Phylogenetic and photo-physiological characterization of newly isolated diatoms from the Ross Sea (Antarctica)

Hedy M. Aardema[1]

Anne-Carlijn Alderkamp[2], Laura Z. Filliger[3], Bethany D. Jenkins[3]

Supported by NSF

[1] **University of Groningen**
The Netherlands

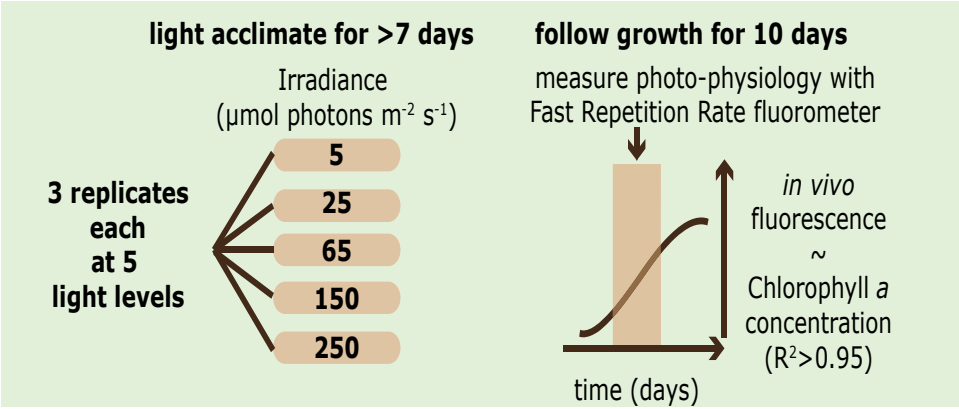
[2] **Stanford University**
USA

[3] **University of Rhode Island**
USA

Identify isolates

- Sequence two rDNA regions: V4 and internal transcribed spacer (ITS)
- Compare sequence to NCBI BLAST database for identification

Photo-physiological characterization



- Compare six diatom isolates to two *Phaeocystis antarctica* strains
- Photo-physiological parameters: F_v/F_m -the maximum photochemical efficiency of photosystem II (PS II)

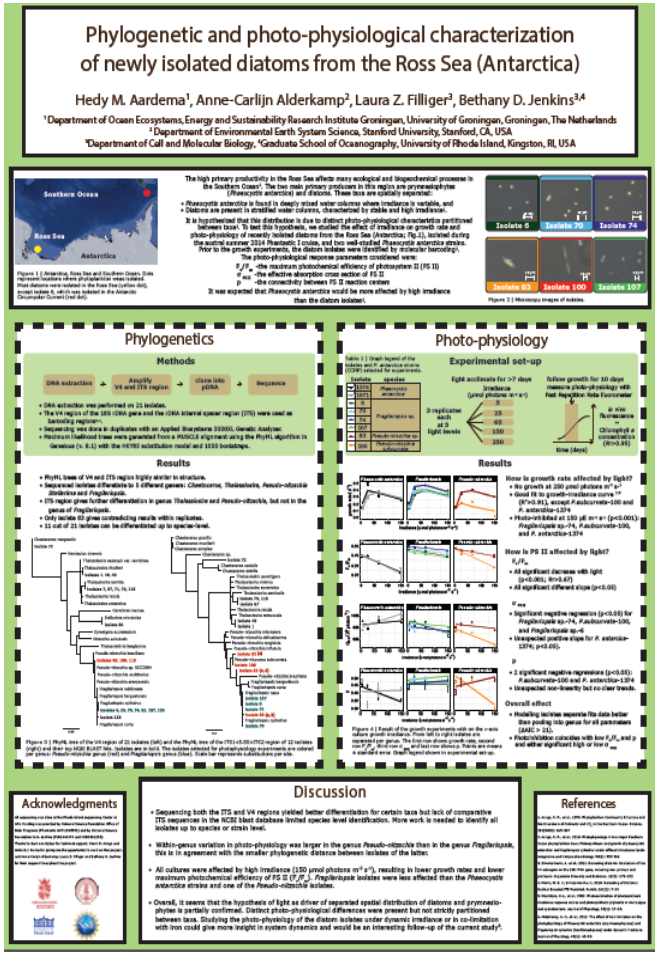
  σ_{PSII} -the effective absorption cross section of PS II

  p -the connectivity between PS II reaction centers

Are there differences in photo-physiology between diatom isolates?

How do they compare to *Phaeocystis antarctica*?

How does this relate to spatial distribution in the Ross Sea?



Characterizing Southern Ocean diatom community composition

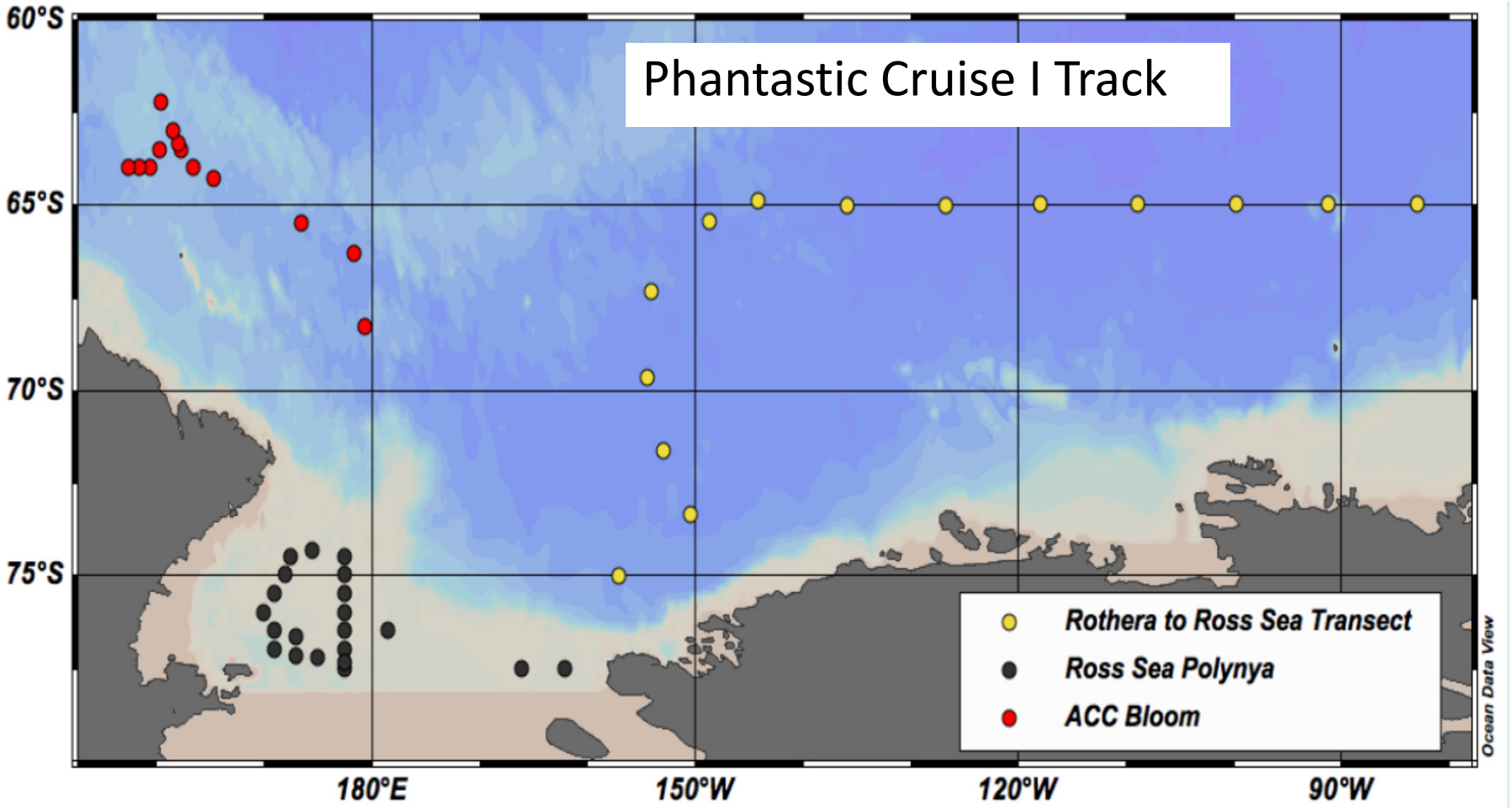
Laura Filliger (funded by NSF GRFP)

University of Rhode Island, Graduate Student – Jenkins lab

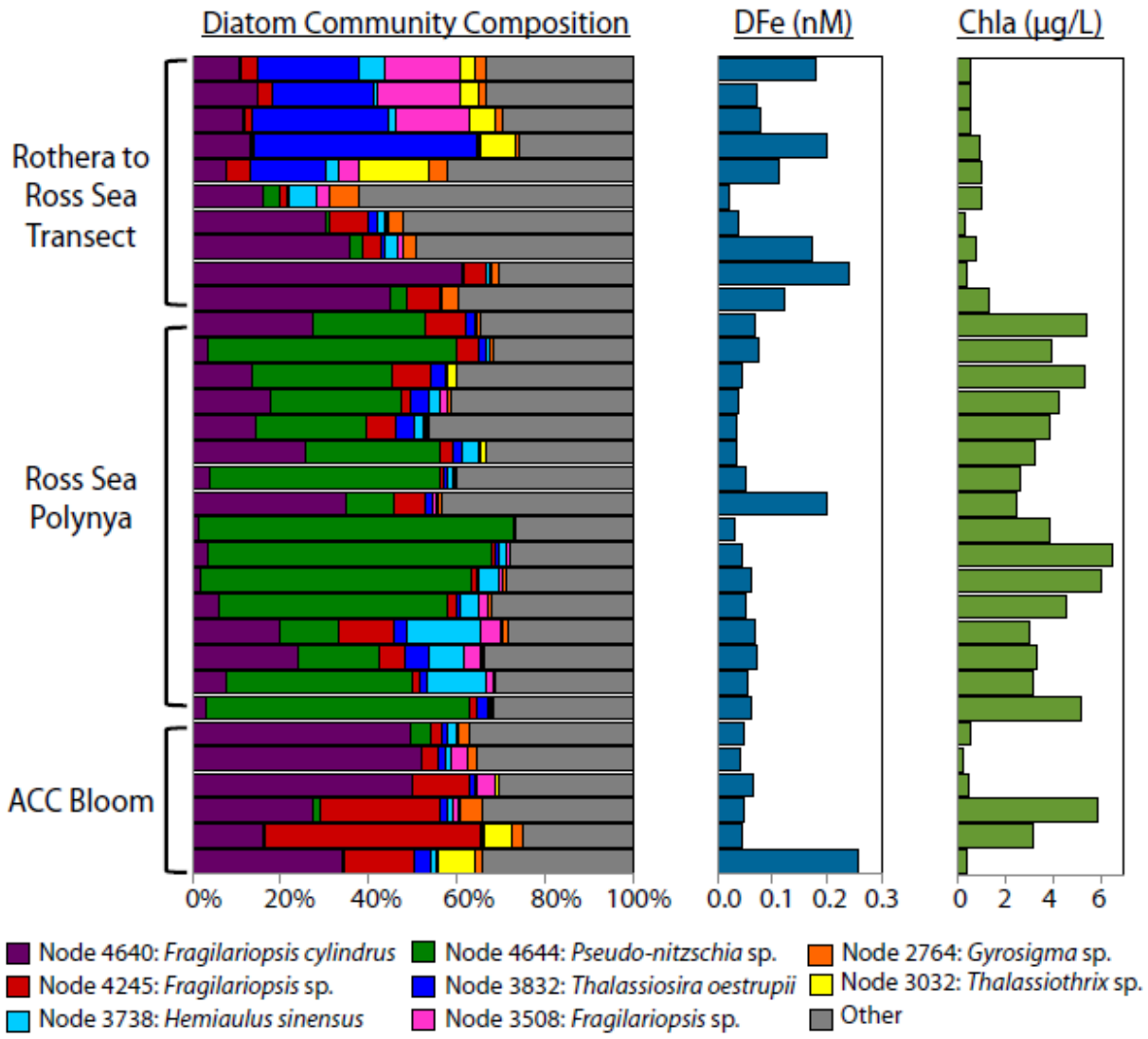
Collaboration with Kevin Arrigo's (Stanford) and Anton Post's (MBL/URI) labs

Funded by NSF

- Can we differentiate Fe stress response in SO diatoms?
- Established culture collection of ~300 isolates to develop ecologically relevant laboratory models



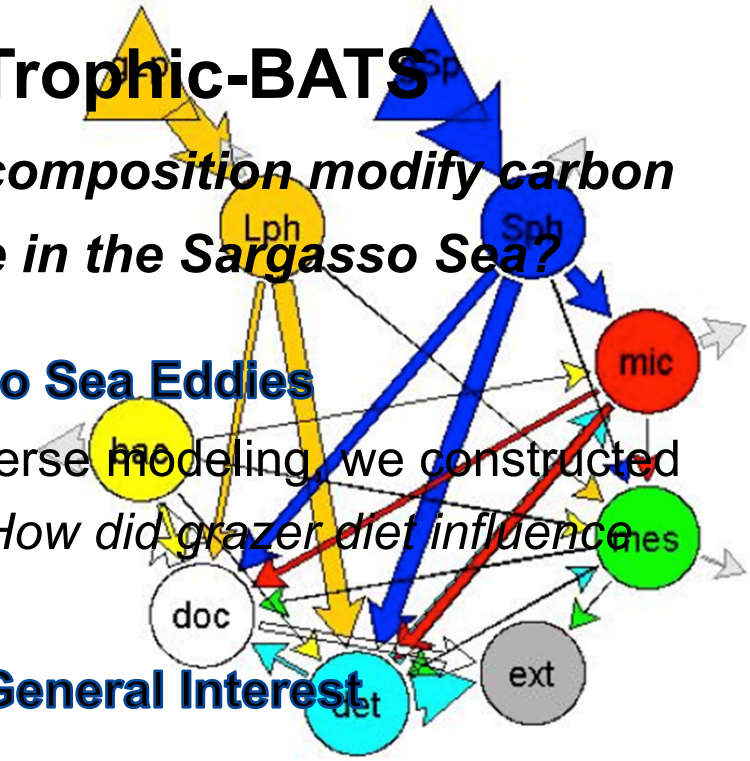
- Characterized *in situ* diatom community composition across regions of varying Fe levels



- Matched diatoms in our collection to dominant taxa

4 cruises in Sargasso Sea: Trophic-BATS

How does planktonic community composition modify carbon export from the euphotic zone in the Sargasso Sea?



Planktonic Food Webs in Two Sargasso Sea Eddies

Combining *in situ* measurements and inverse modeling, we constructed food webs in two Sargasso Sea eddies. *How did grazer diet influence carbon export?*

Come find out today! Section: General Interest

1 cruise along Labrador - Sargasso Sea transect: Dimensions of Biodiversity

How is productivity partitioned among the three main groups of picophytoplankton along a nutrient/productivity gradient?

Bridget Bachman
PhD Candidate
Adviser: Tammi Richardson
University of South Carolina

Who is there? What are they doing?

- **Future research interests:**
  - **To combine omic tools with rate measurements to investigate how diversity within communities impacts functional diversity in oligotrophic waters.**
    - **Photophysiology**

Bridget Bachman
PhD Candidate
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Who is there? What are they doing?

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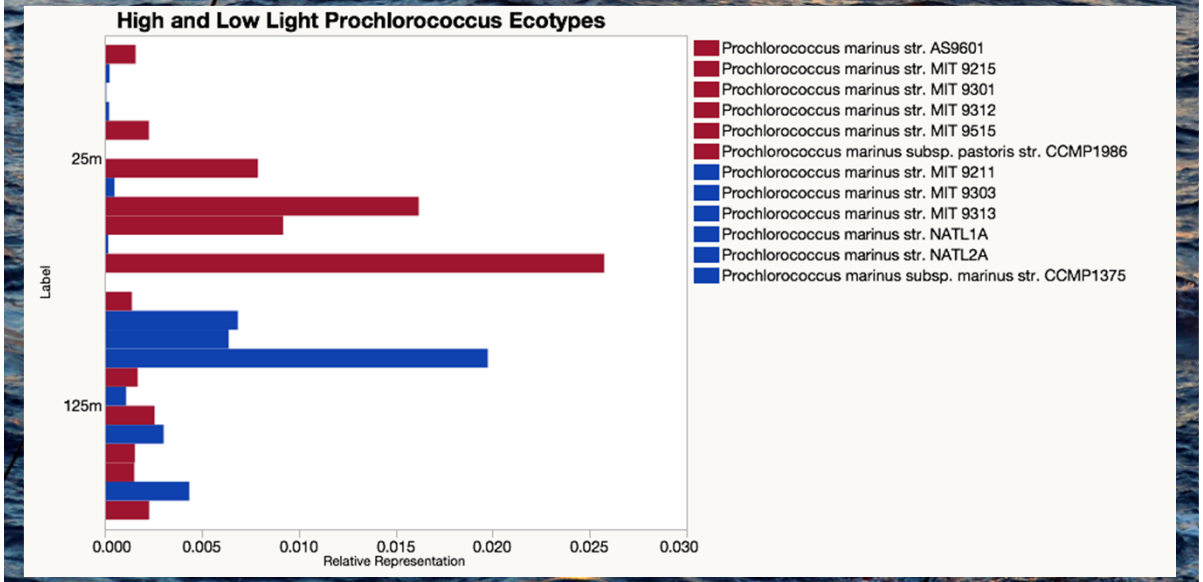
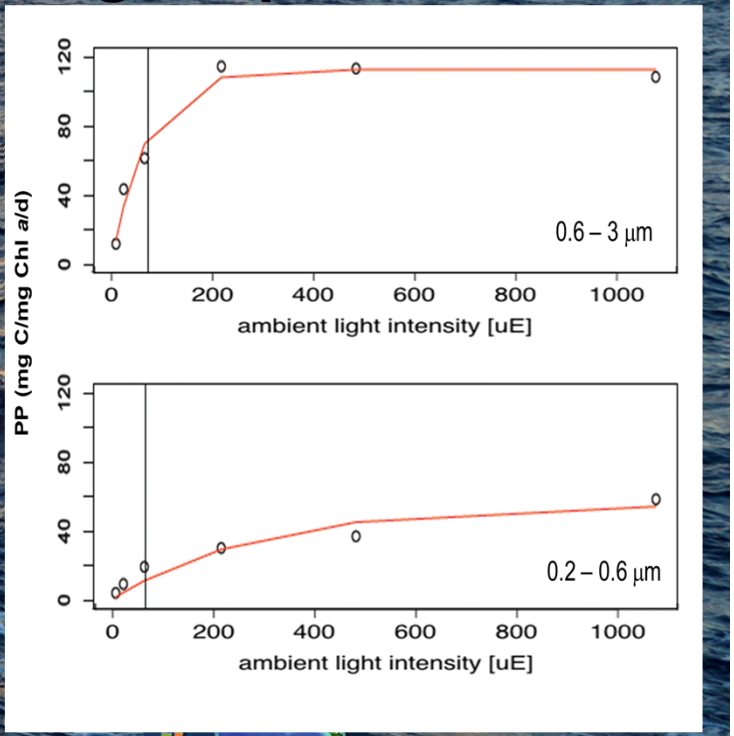
  - **To combine omic tools with rate measurements to investigate how diversity within communities impacts functional diversity in oligotrophic waters.**





Data from C-MORE 2015 summer course

Bridget Bachman
PhD Candidate
Adviser: Tammi Richardson
University of South Carolina

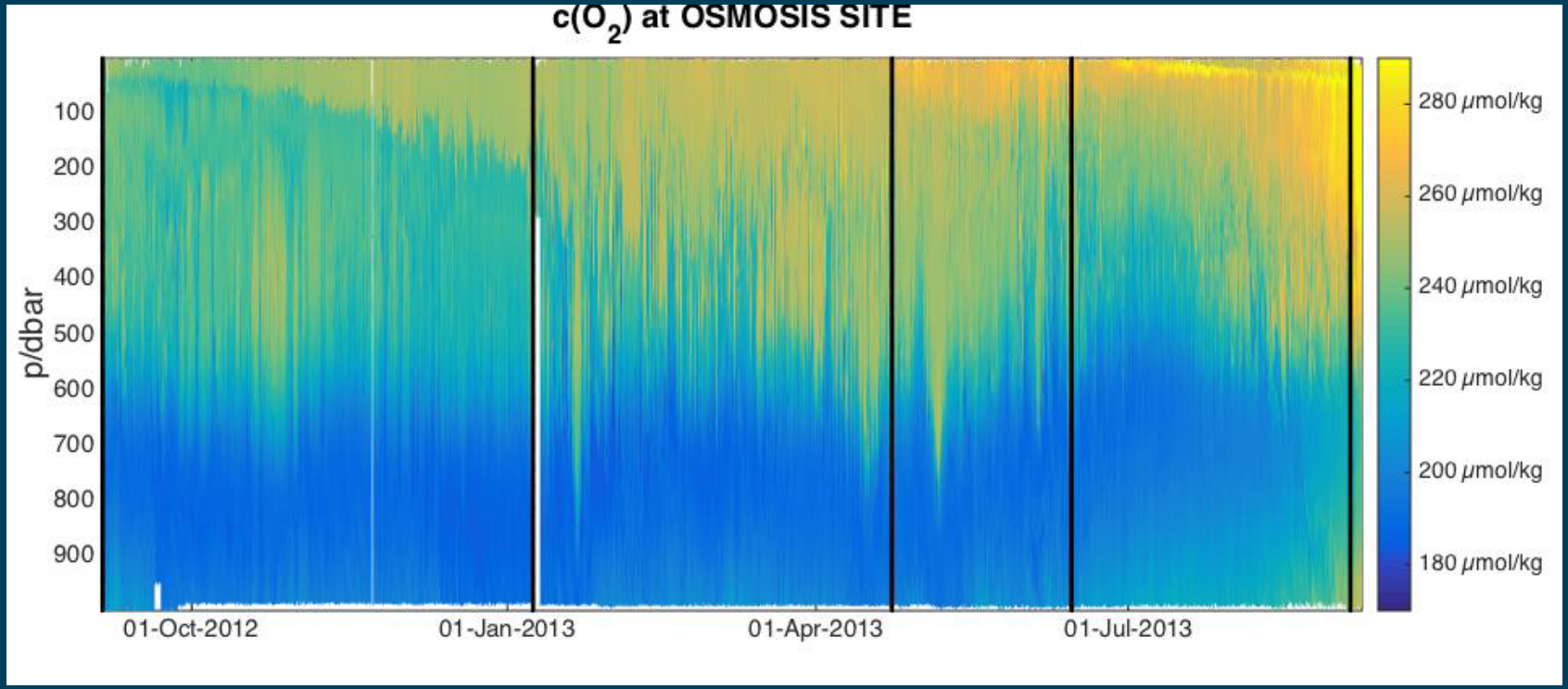
July 29, 2015

Dissolved oxygen concentration at the PAP site: resolving O_2 annual dynamics at an eddy rich site in the temperate North Atlantic using Seagliders

Umberto Binetti
University of East Anglia
Centre for Ocean and Atmospheric Sciences
School of Environmental Sciences
Norwich, UK

C(O2) at OSMOSIS site
Sep 2012 – Sep 2013

University of East Anglia

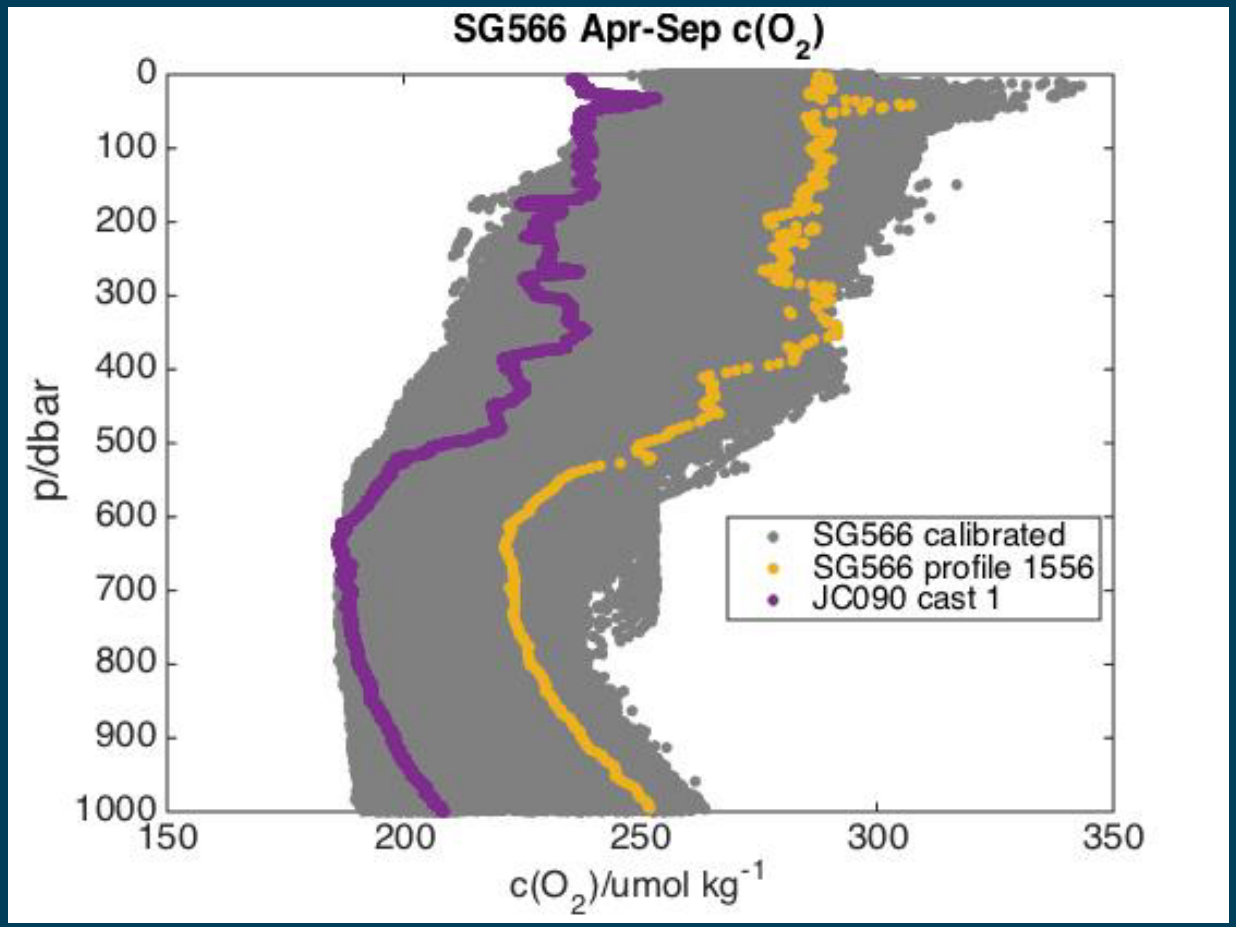


SG566 SG502 SG566

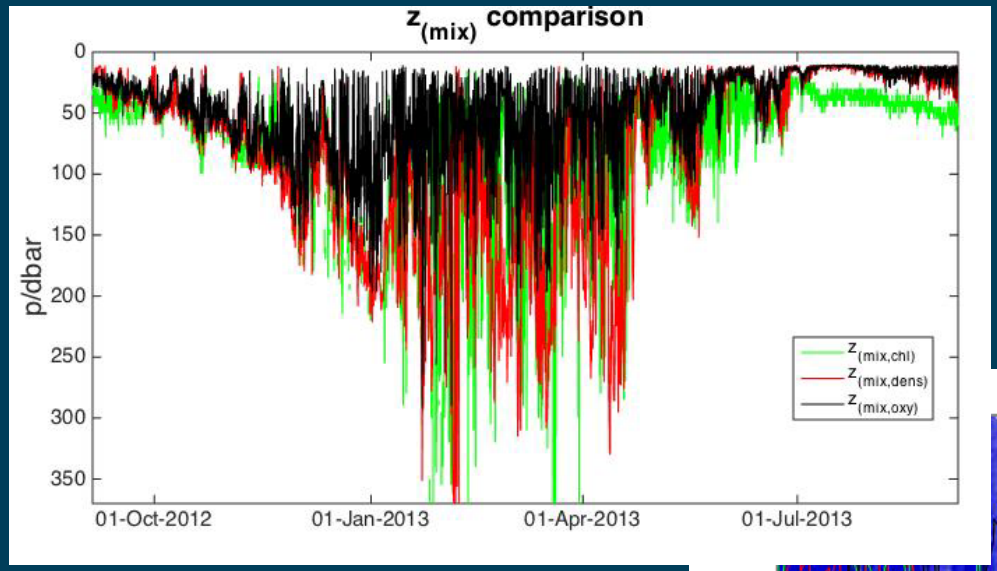
D381 CE13001 JC085 JC087 JC090

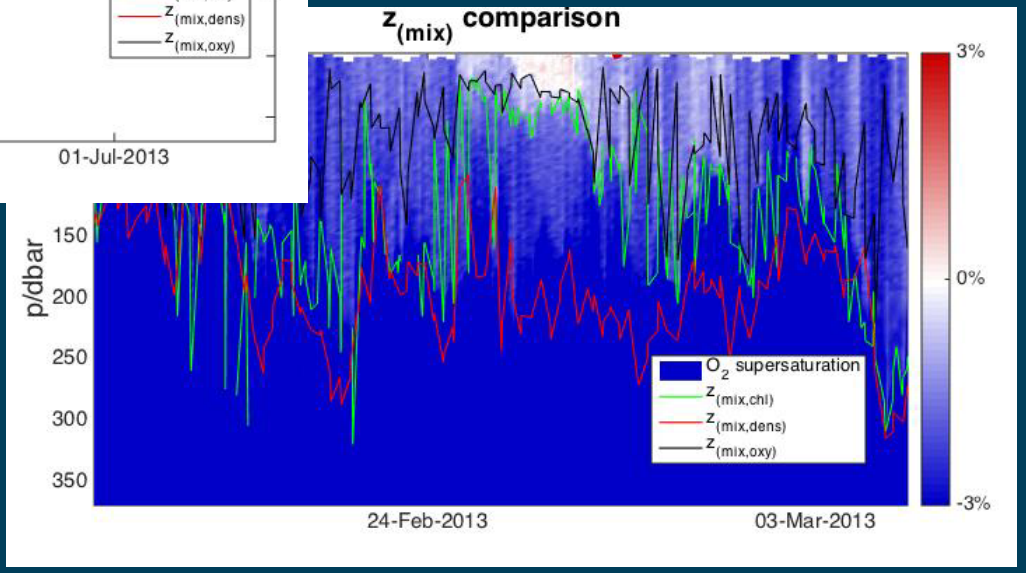
C(O2) at OSMOSIS site
Sep 2012 – Sep 2013

University of East Anglia



Mixed layer – Mixing layer



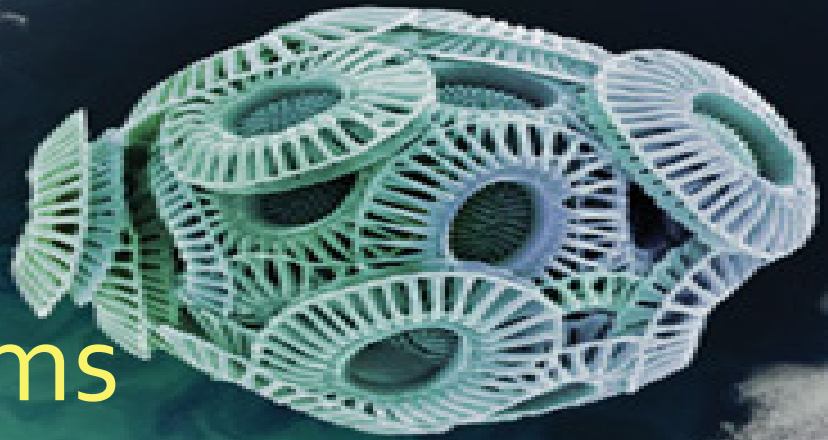


July 29, 2015

University of East Anglia

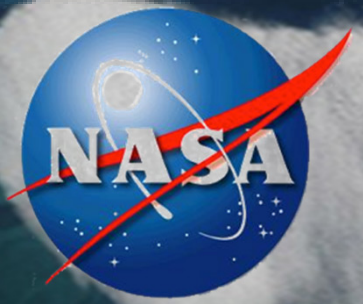
Thanks for your attention

Physical processes governing phytoplankton blooms in the Southern Ocean



Magdalena Carranza

Advisor: Sarah Gille

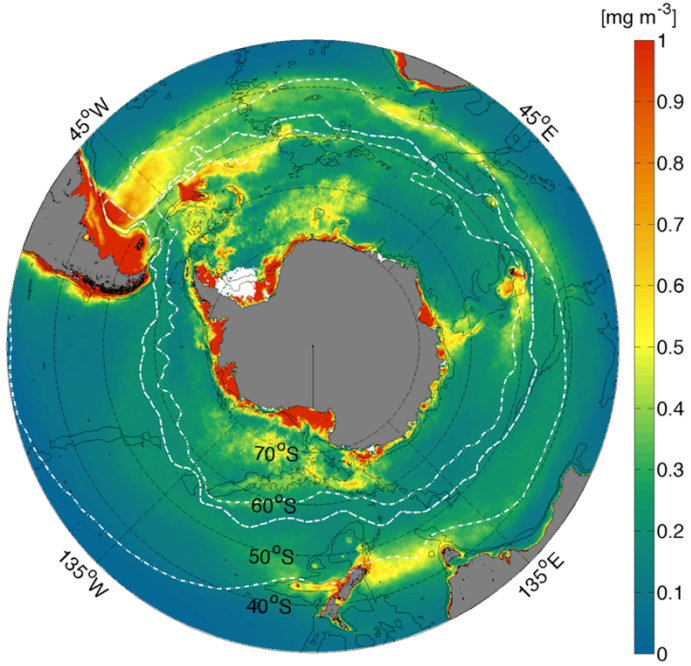


Scripps Institution of Oceanography

California, USA

Physical controls on Chl-a variability: a satellite perspective

Summer Chl-a

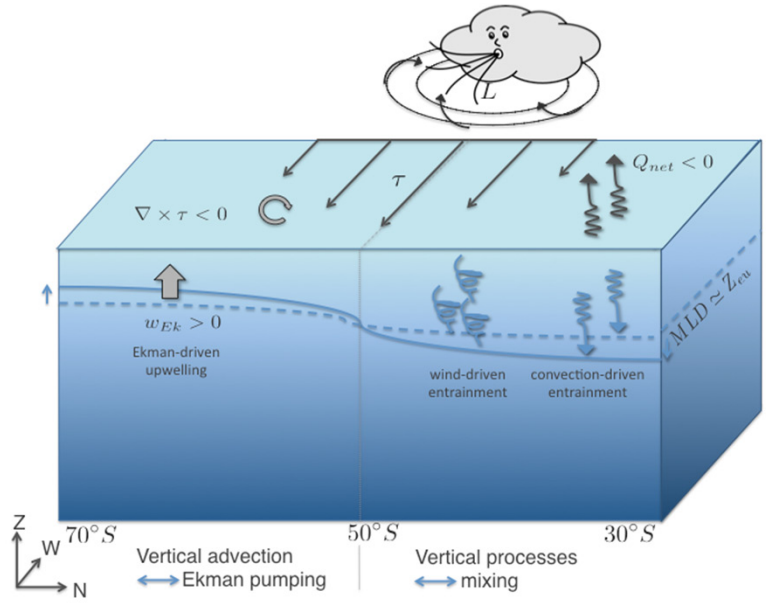


Focus on atmospheric synoptic storm scales:
< 10 days, > 700 km

Atmospheric forcing:

- Mixed-layer depth (MLD) deepening
- Ekman Pumping

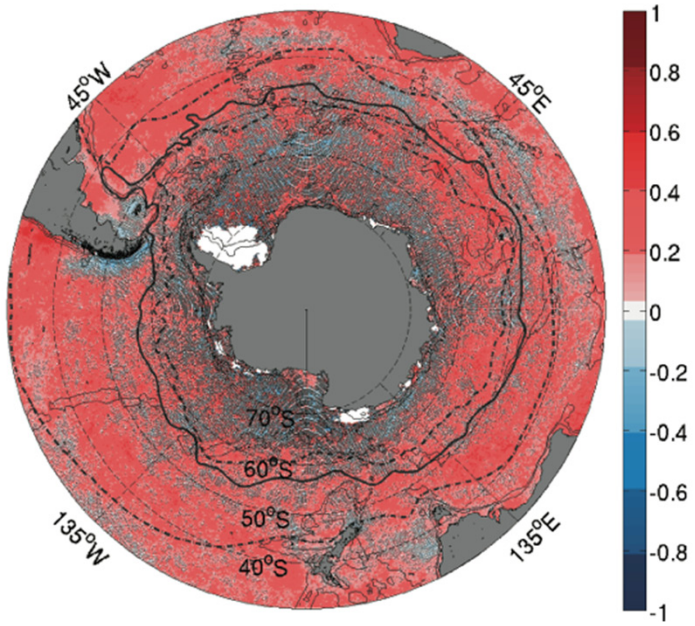
$$w_e(-h) \sim \frac{\partial h}{\partial t} + w_{Ek}(-h)$$



✓ Carranza and Gille (2015). "Southern Ocean wind-driven entrainment enhances satellite chlorophyll-a through the summer", JGR

Physical controls on Chl-a variability: a satellite perspective

Wind speed vs Chl-a

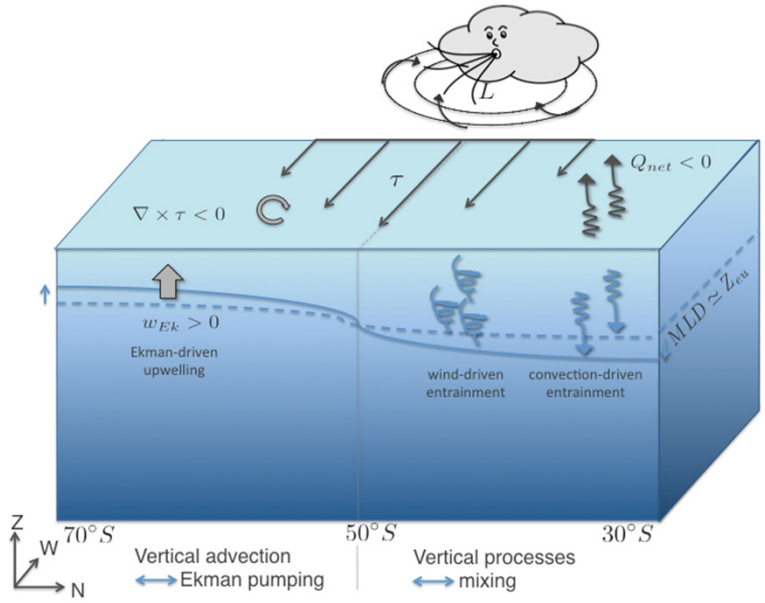


- High winds enhance satellite Chl-a

Atmospheric forcing:

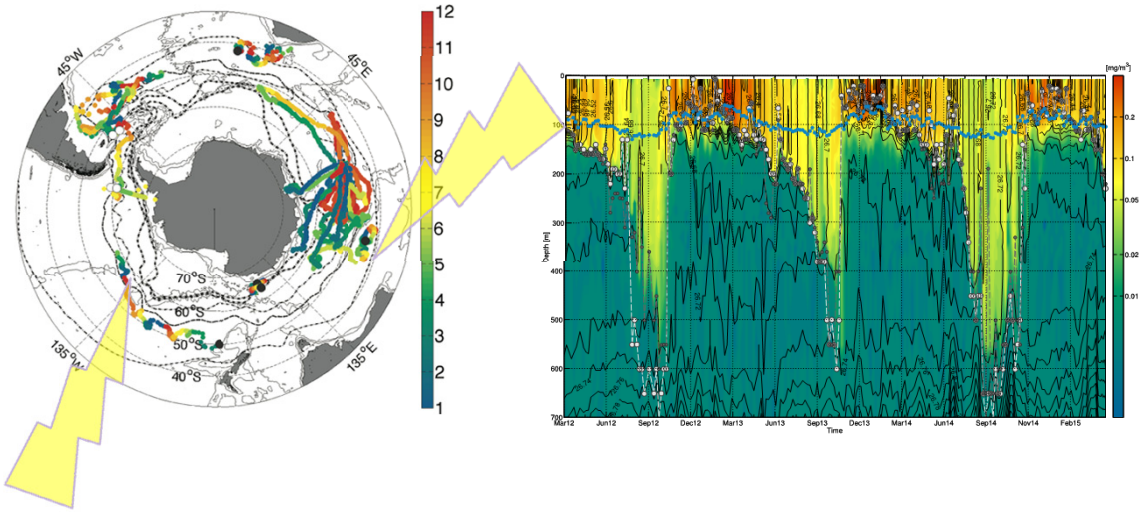
- Mixed-layer depth (MLD) deepening
- Ekman Pumping

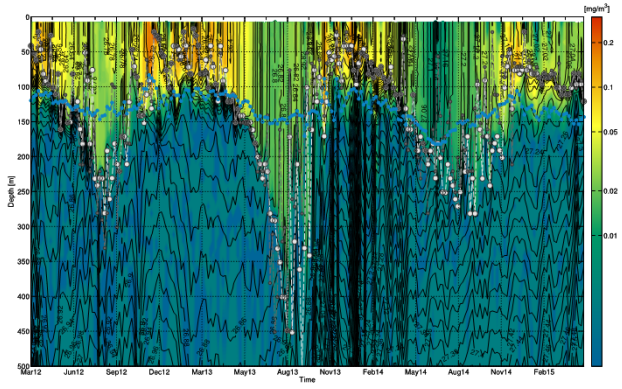
$$w_e(-h) \sim \frac{\partial h}{\partial t} + w_{Ek}(-h)$$

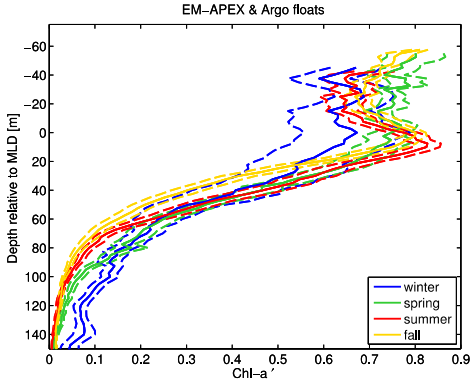


✓ Carranza and Gille (2015). "Southern Ocean wind-driven entrainment enhances satellite chlorophyll-a through the summer", JGR

Vertical structure of Chl-a profiles: from floats and elephant-seal data



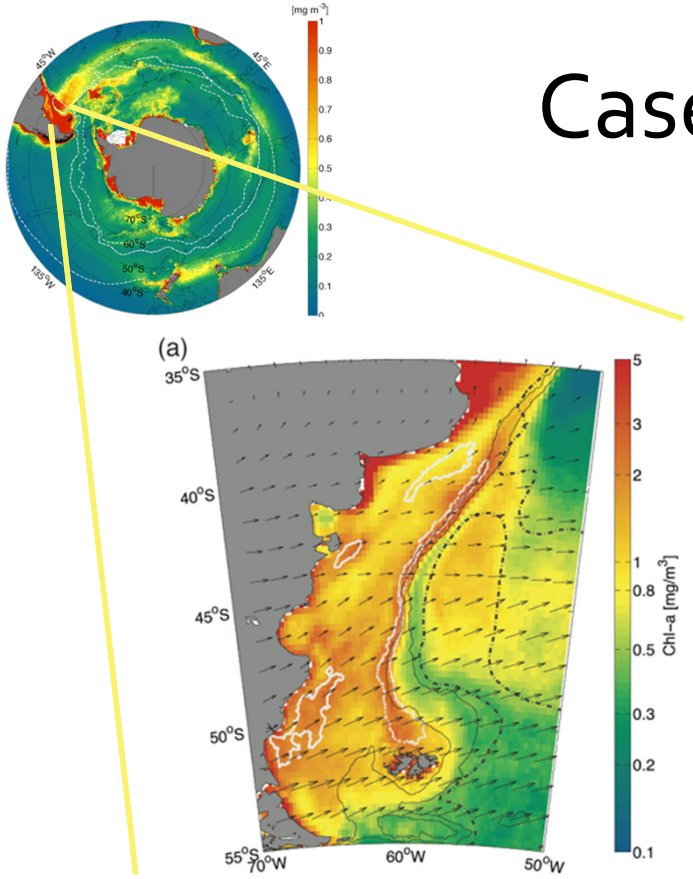




- Surface Chl-a is a good proxy for Chl-a content in the euphotic zone (ZEU), but poorly represent Chl-a within the mixed layer (MLD)
- Subsurface blooms are not uncommon and they are found close to the MLD

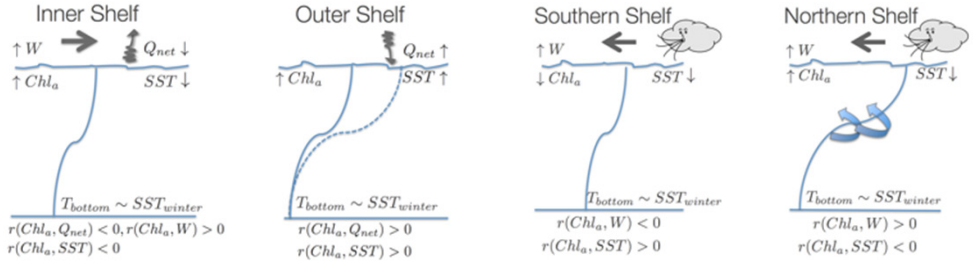
✓ Carranza et al. (2015). " Mixed-layer depth, euphotic depth and Chl-a variability in the Southern Ocean", in review for *Journal of Marine Sciences*

Case study: Patagonian shelf

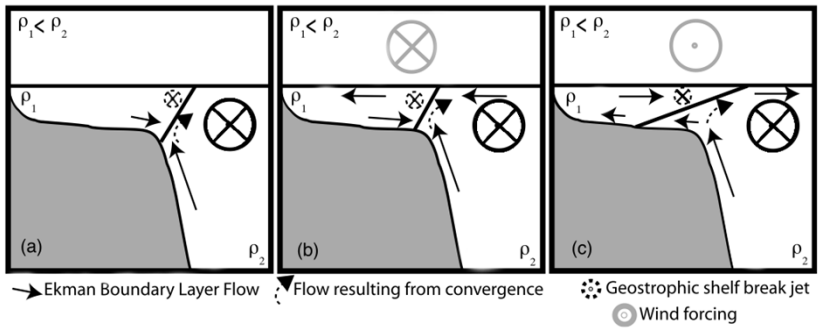


Role of the atmospheric forcing in setting up stratification and mixing:

Spring vs Summer



Wind-front interaction at the shelf-break front:



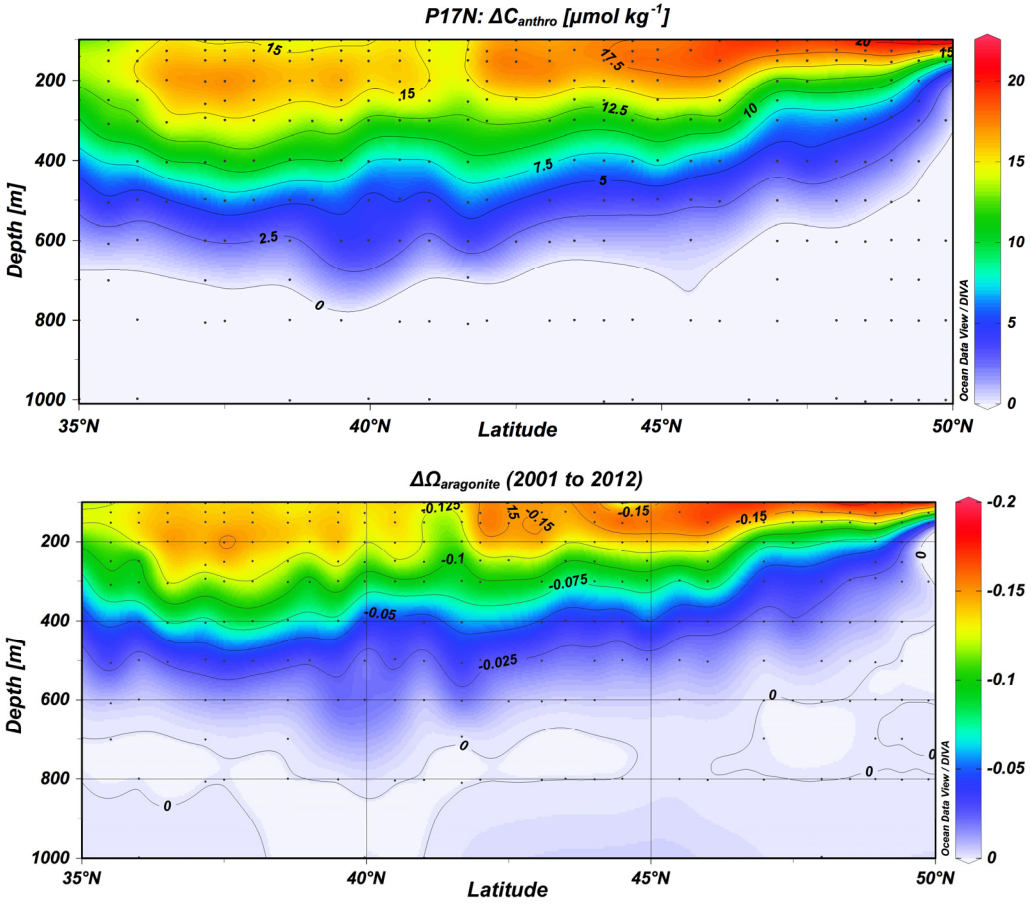
modified for the SH from Siedlecki et al. (2011)

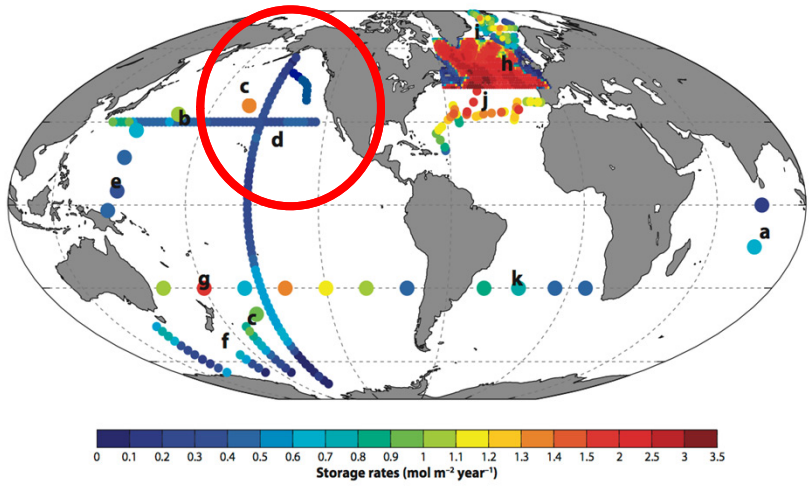
- Wind modulation of upwelling at the shelf-break front off Patagonia

✓ Carranza et al. " Wind modulation of upwelling at the shelf-break front off Patagonia", in preparation

Sophie Chu PhD candidate MIT-WHOI JP

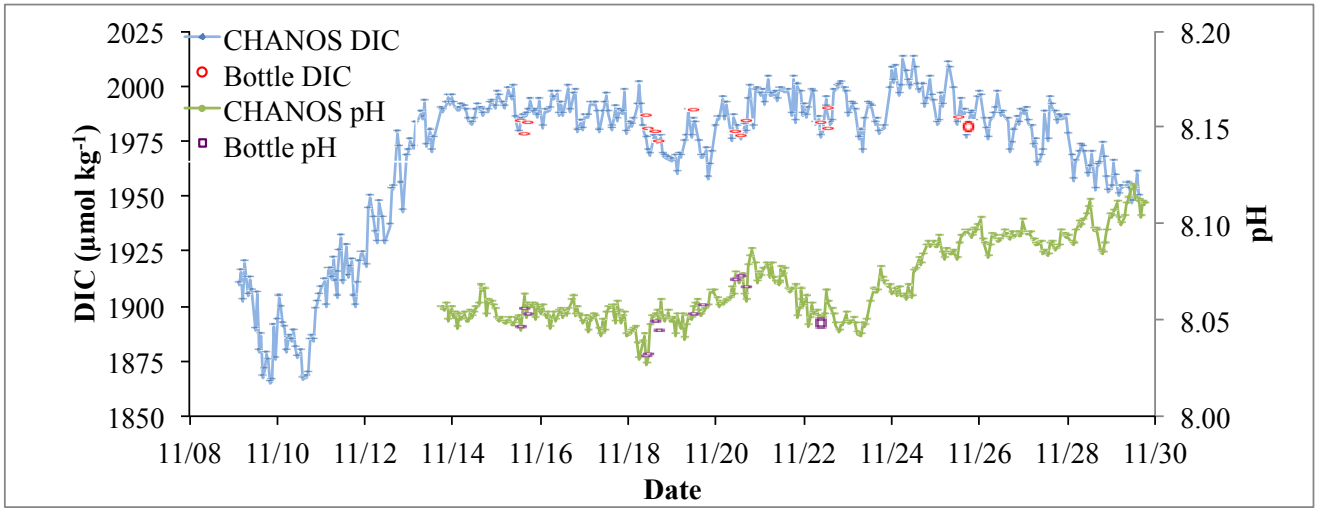
Estimating the change in anthropogenic CO2 storage in the Northeast Pacific using eMLR

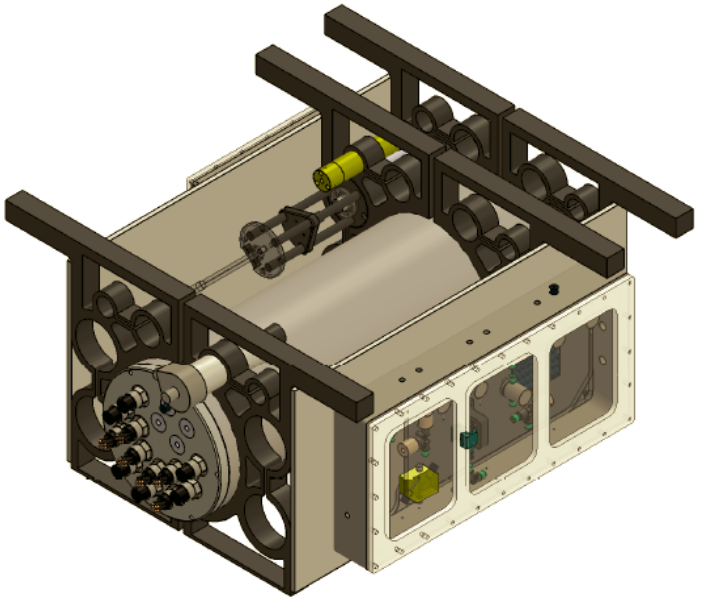




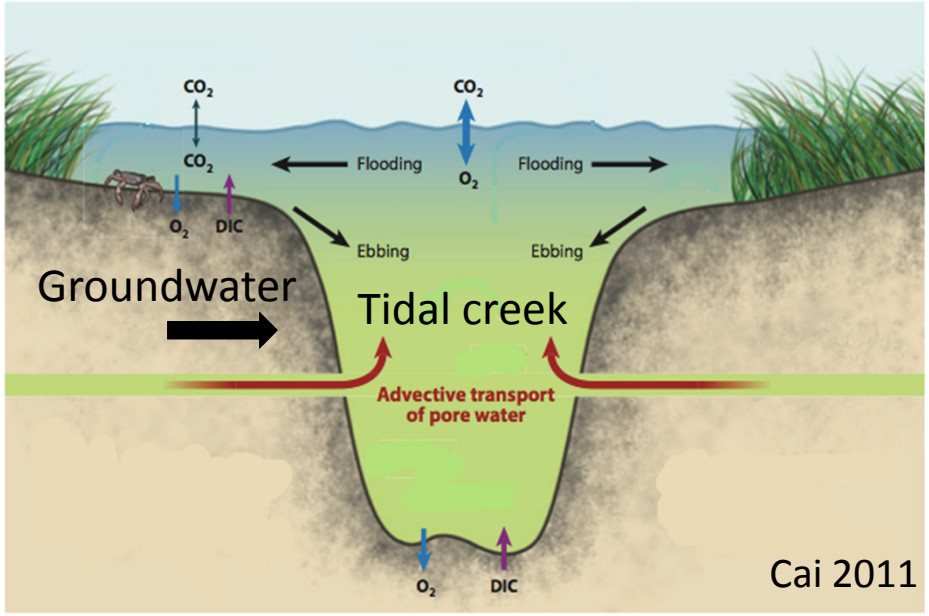
Sabine and Tanhua 2010

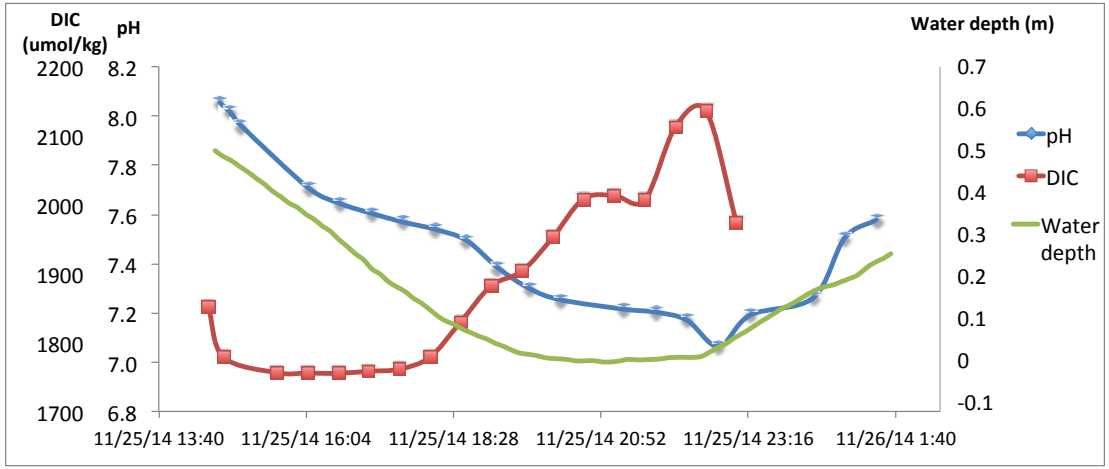
CHANnelized Optical Sensor (CHANOS) simultaneously measures DIC and pH at high-resolution





Accurately quantify inorganic carbon and alkalinity fluxes export fluxes from an intertidal salt marsh

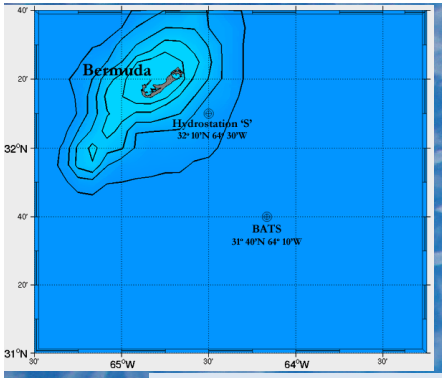


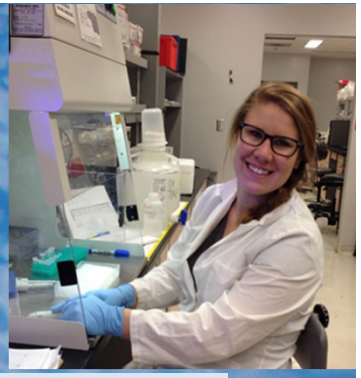


Cyanobacteria, too small to sink? Strain specific contribution of cyanobacteria to the carbon export in the Sargasso Sea.

Francesca De Martini
Environmental Life Sciences PhD student
Arizona State University, Tempe, AZ, USA

Co-authors: Susanne Neuer, Demetra Hamill and Julie Robidart





We sampled the euphotic zone and sinking particles (150m particle traps)

We targeted specific clades of *Synechococcus* and *Prochlorococcus* using qPCR in two different seasons (late winter and summer) 2012

1) The export of the different strains of *Synechococcus* was positively related to their abundance in the water column, higher in spring (~18% of total POC flux) than during the summer (~2% of total POC flux).

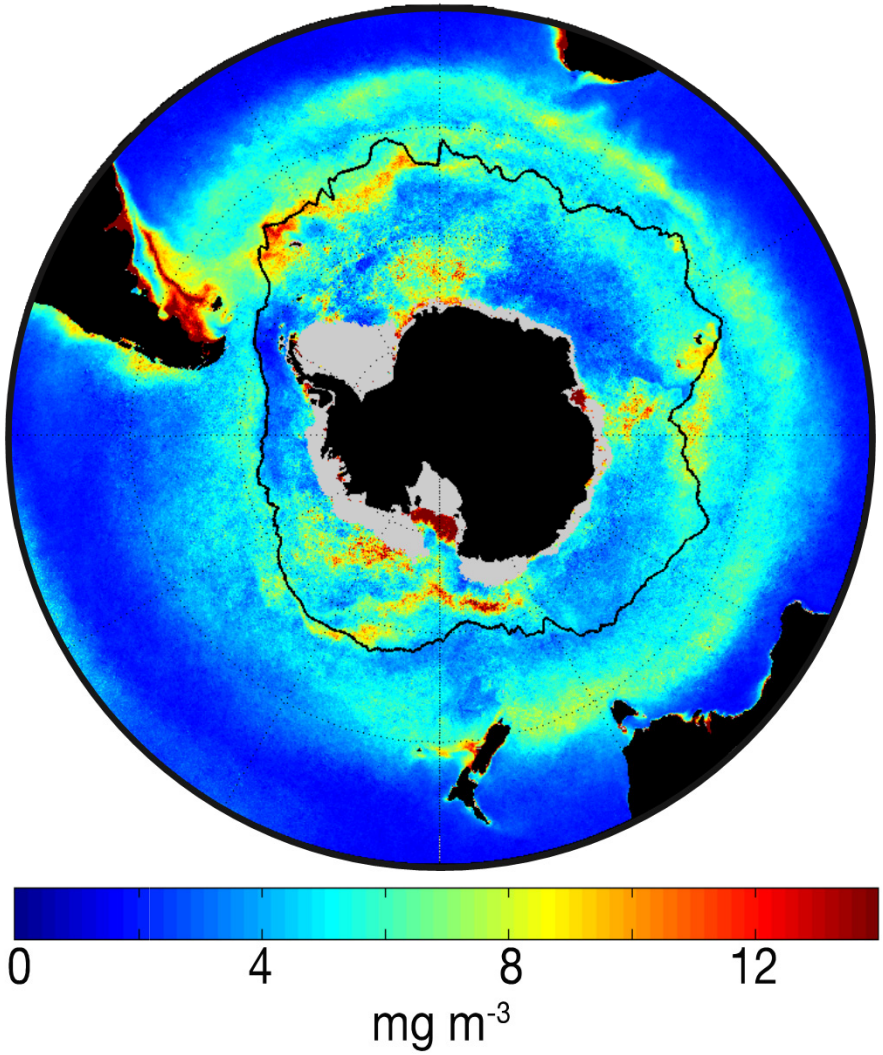
2) The export of the *Prochlorococcus* community was always low (< 1% of total POC flux), independently of their abundance in the water column

Recent changes in Southern Ocean biogeochemistry and biogeography

Natalie Freeman

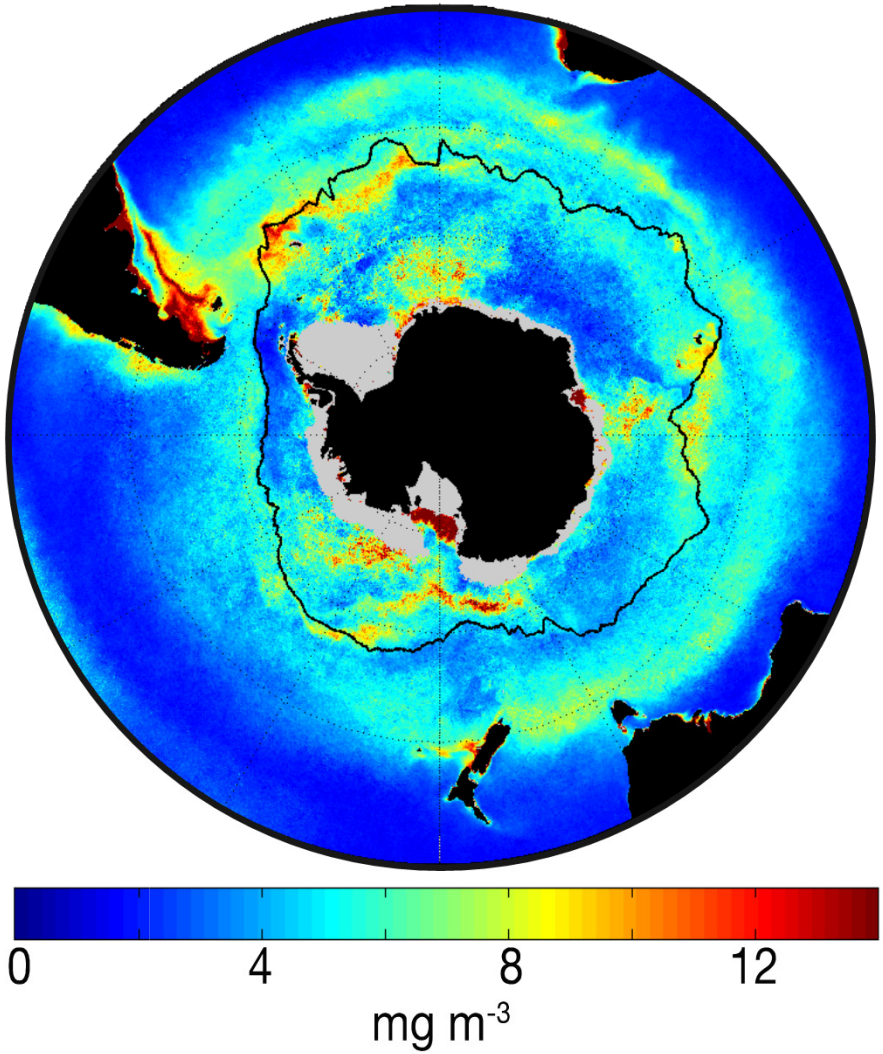
University of Colorado at Boulder
Department of Atmospheric and Oceanic Sciences
Institute of Arctic and Alpine Research

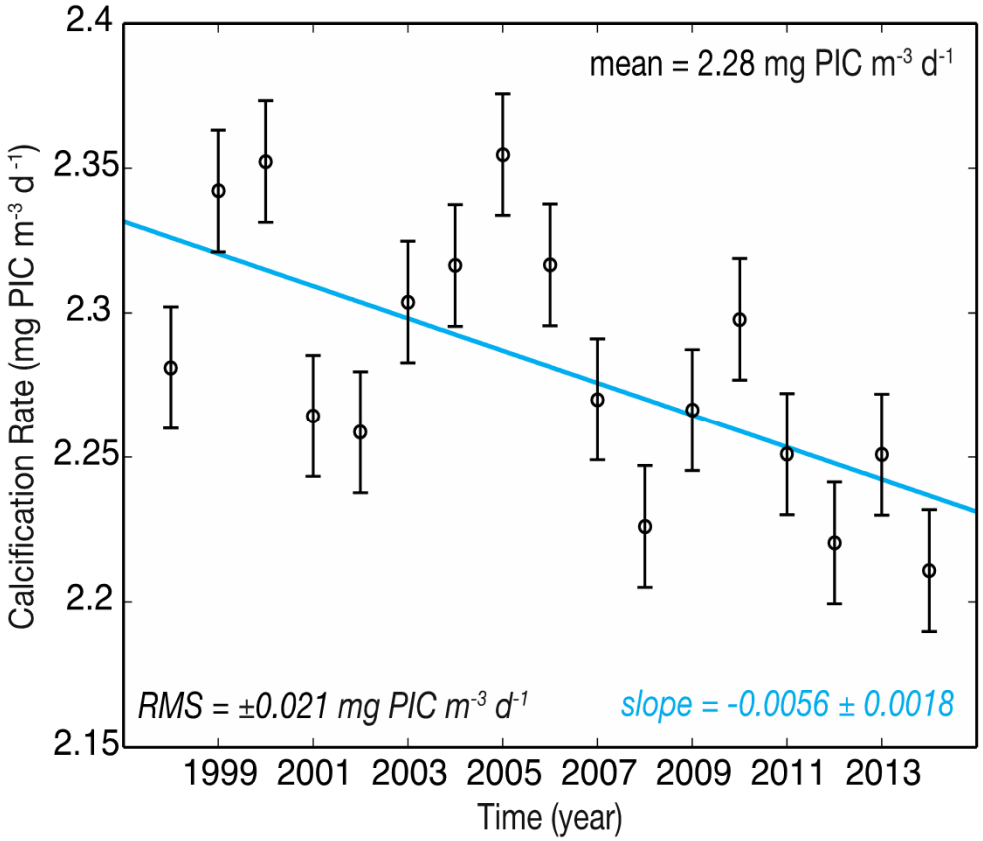
PIC and calcification changes



Freeman & Lovenduski (2015)

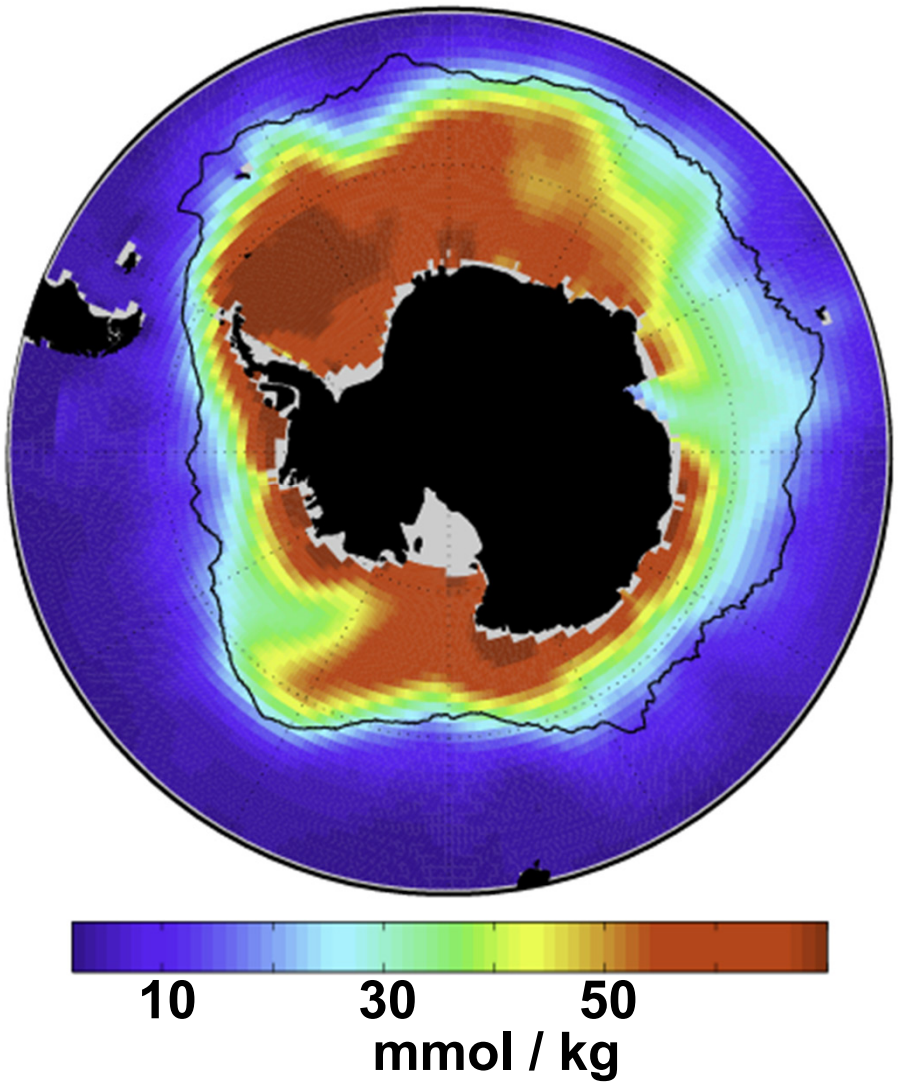
PIC and calcification changes



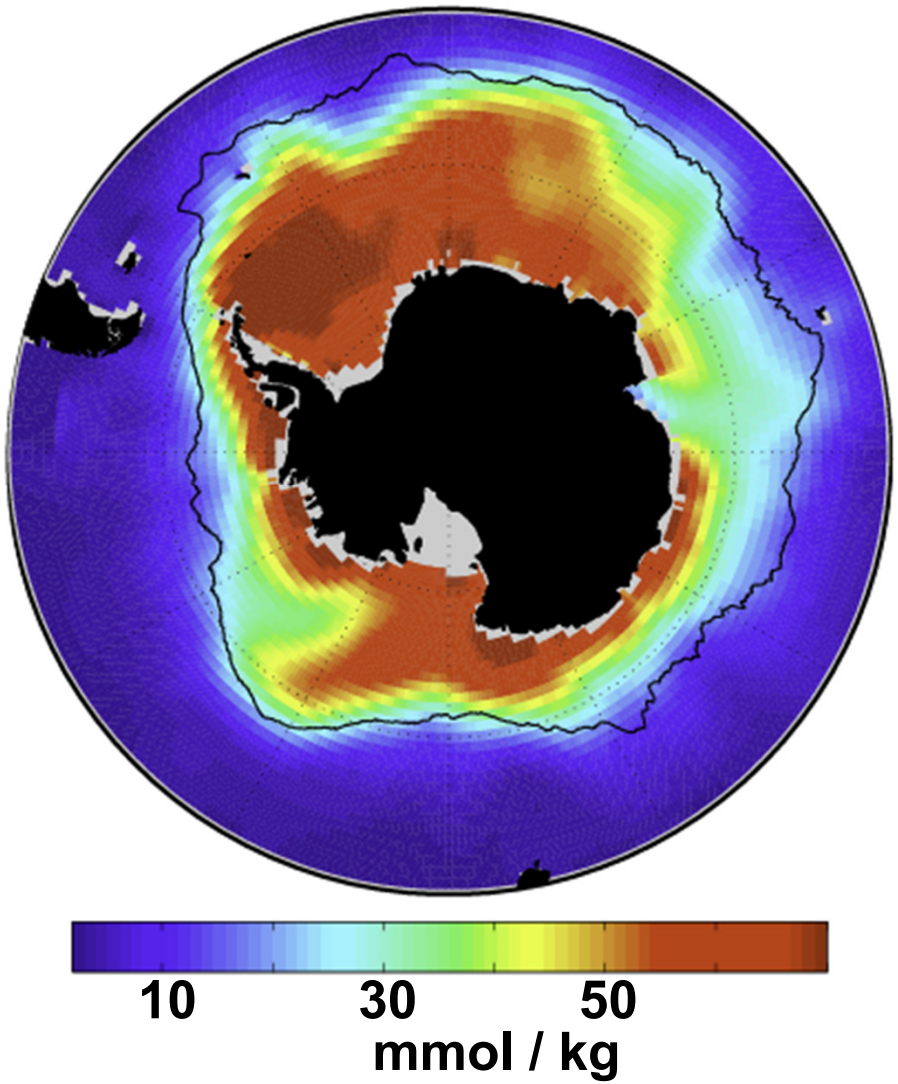


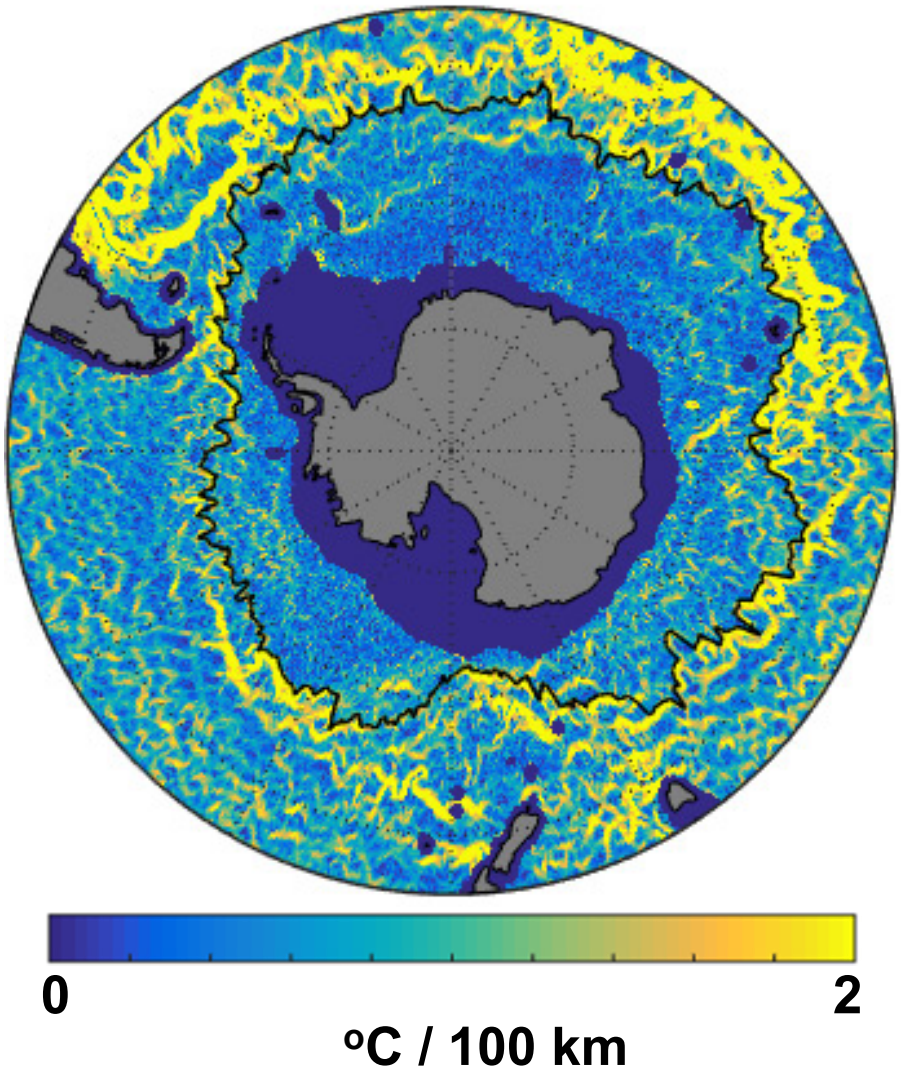
Freeman & Lovenduski (2015)

Impact of Antarctic Polar Front variability



Impact of Antarctic Polar Front variability

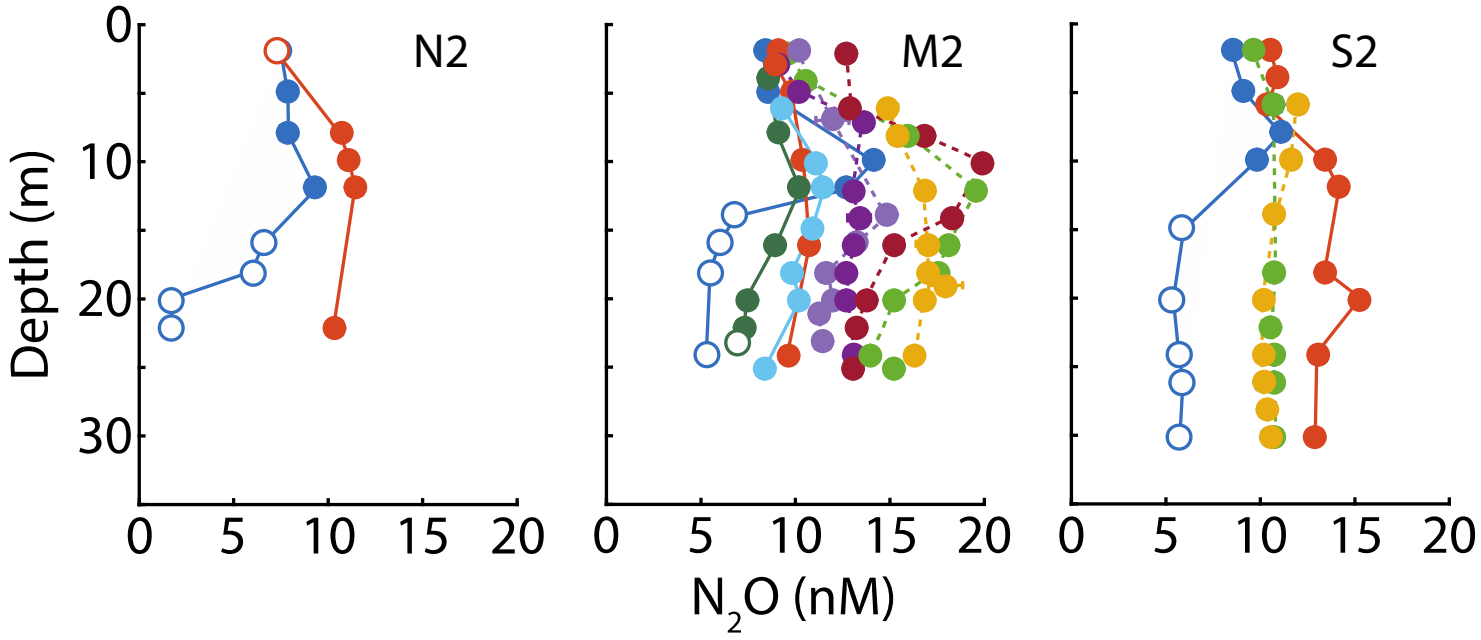




A control volume approach for estimating nitrous oxide (N_2O) production and consumption in the Chesapeake Bay

Sarah M. Laperriere[1], Nicholas J. Nidzieko[1], Rebecca J. Fox[1,2], and Alyson E. Santoro[1]

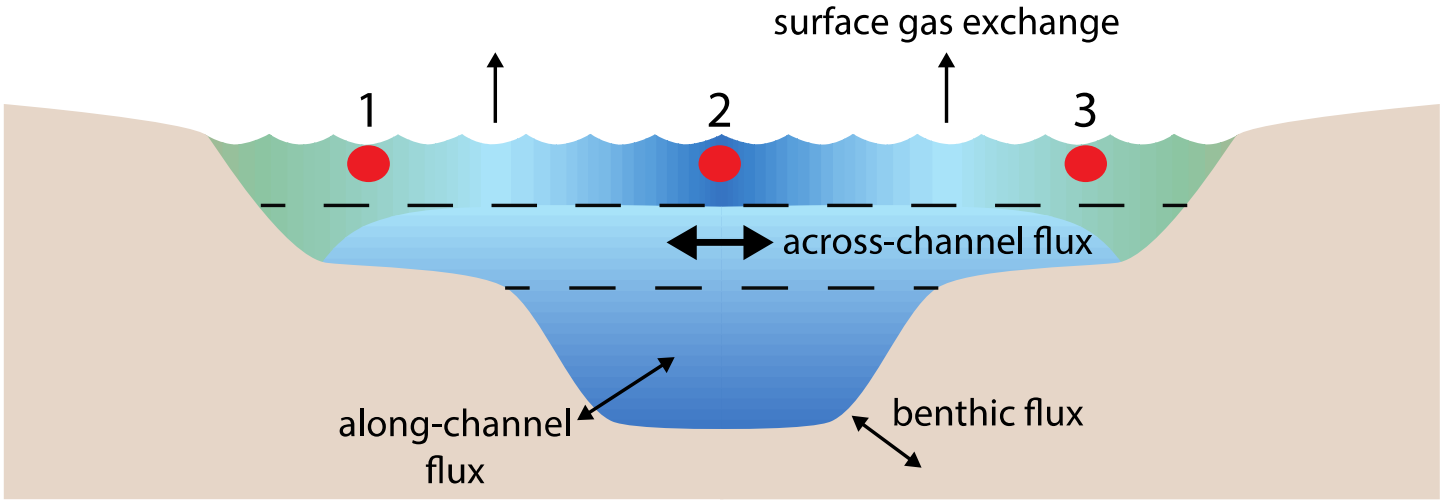
[1]Horn Point Laboratory, University of Maryland Center for Environmental Science
[2]Washington College

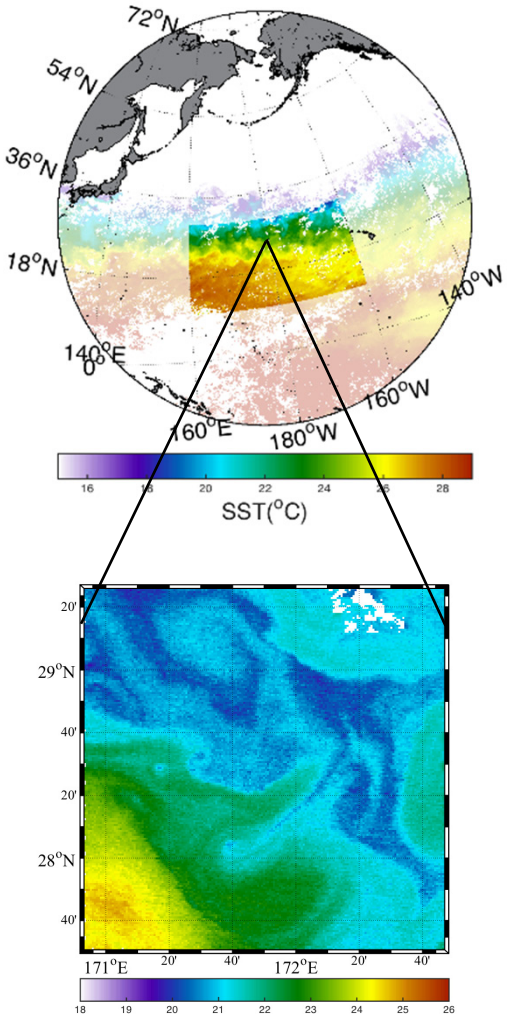


Is the Chesapeake Bay a source or sink for N_2O?

Transport Equation

$$\underbrace{\frac{\partial C}{\partial t}}_{\text{time rate of change of } N_2O \text{ within control volume}} + \underbrace{u\frac{\partial C}{\partial x} + w\frac{\partial C}{\partial z}}_{\text{advective fluxes in and out of control volume}} - \underbrace{V_z\frac{\partial^2 C}{\partial z^2}}_{\text{diffusive fluxes in and out of control volume}} = N_2O \text{ Sources \& Sinks}$$



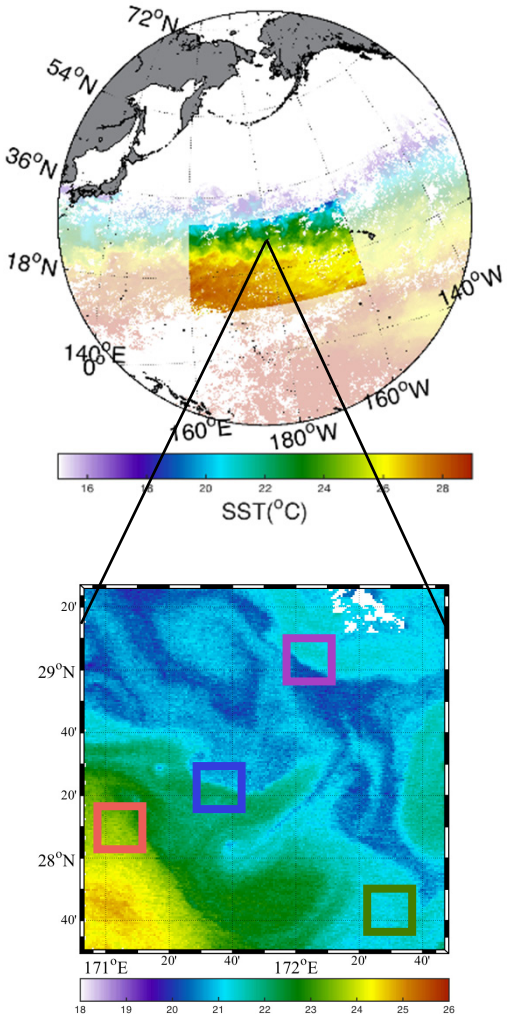


Submesoscale heterogeneity enhances phytoplankton chlorophyll in the North Pacific Subtropical Gyre

Xiao Liu and Naomi M. Levine
The University of Southern California

The submesoscale dynamics is ubiquitous in the upper ocean -

- *in situ* observations are difficult
- Current global climate models cannot address
- Impact on marine ecosystem is poorly understood



The Heterogeneity Index (HI)

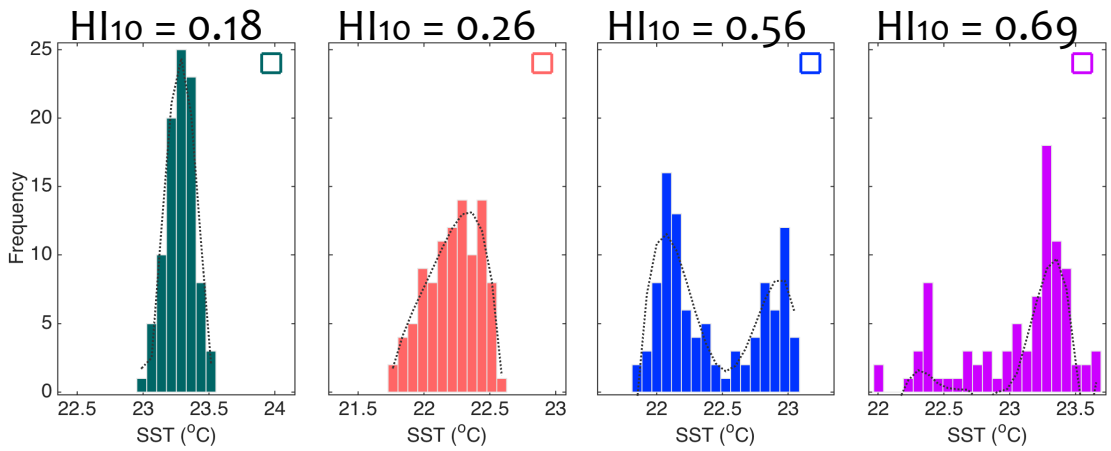
- A new metric for ocean surface patchiness using MODIS/Aqua 1-km SST

standard deviation

$$HI = a(b|\gamma| + c\frac{\sigma}{\sqrt{n}} + dP)$$

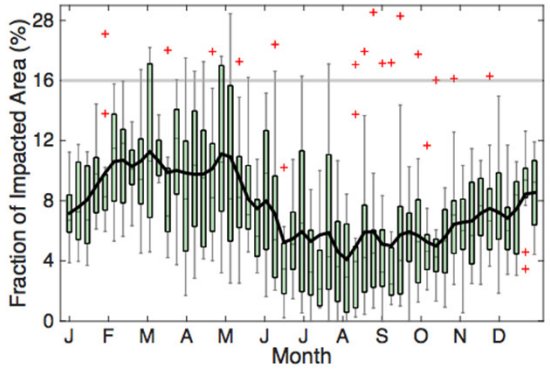
skewness

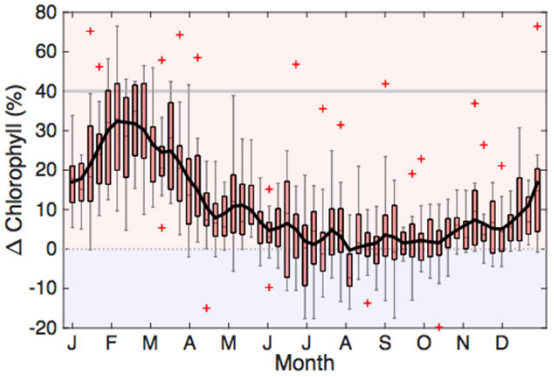
polygon that quantifies dist. deviation from normalcy



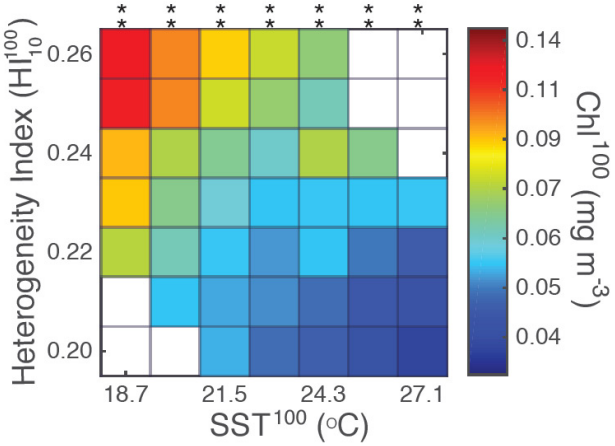
Key conclusions & Implications

Fractional area occupied by structures





Chl enhanced by structures



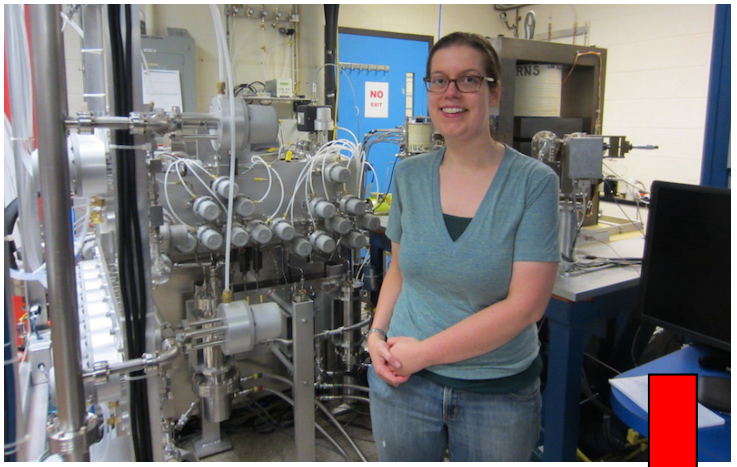
- On average 6.2 % of the area is occupied by fine-scale (<10 km) structures;
- Chlorophyll concentrations are enhanced by fine-scale heterogeneity, with an average increase of 32% (max. 73%) during the early spring.
- This impact of submesoscale physics on phytoplankton may offset the warming-induced weakening of the carbon pump.
- Parameterizing global climate models for the impact of submesoscale dynamics is needed.

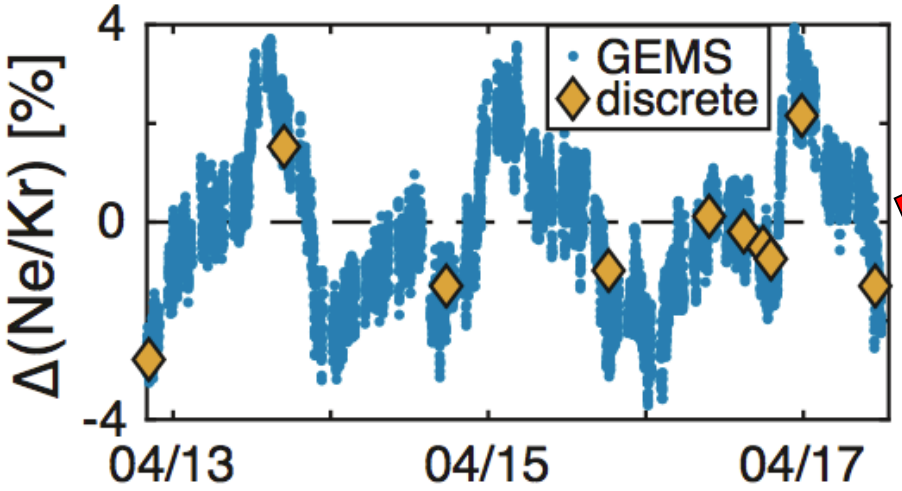
We acknowledge NASA for providing satellite data, and NSF, NASA, USC for funding support.

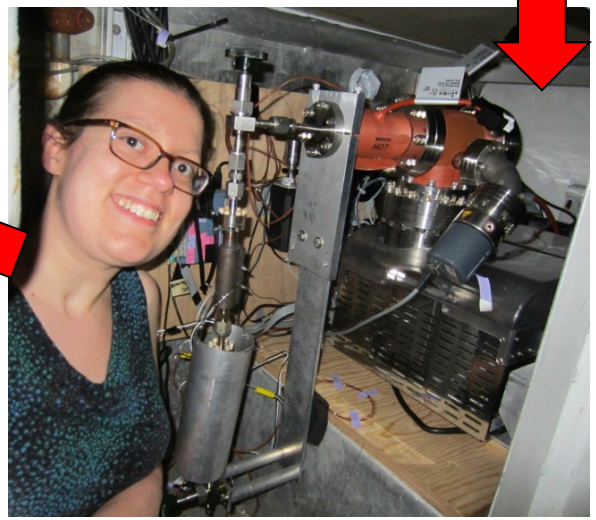
A **field-deployable gas equilibration mass spectrometer** for continuous measurements of dissolved Ne, Ar, Kr, and Xe

Cara Manning (MIT-WHOI)

Advisors: Rachel Stanley and
David (Roo) Nicholson

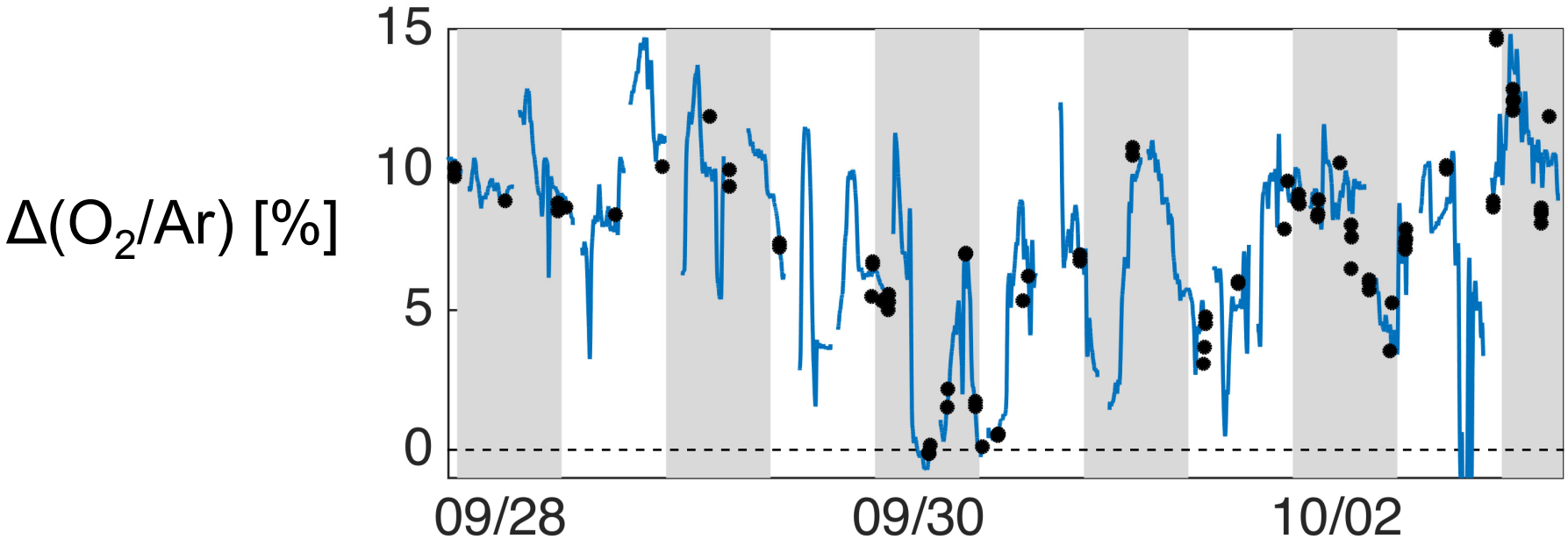






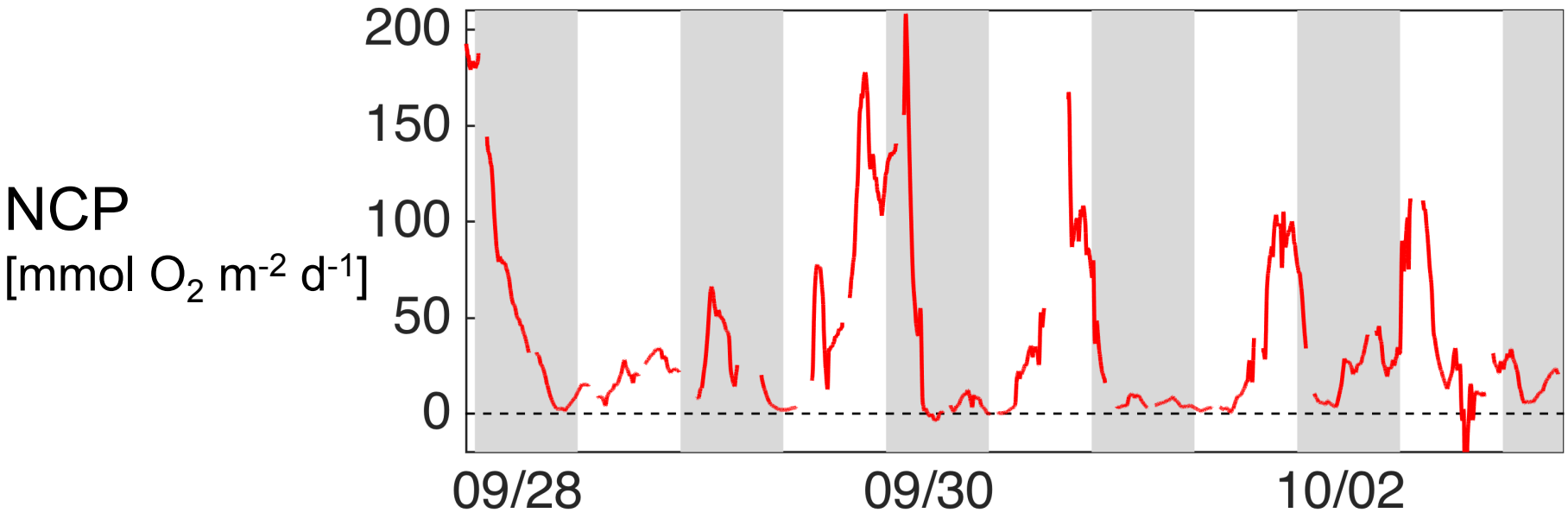
Poster: Net and gross productivity during a Lagrangian experiment in coastal California from gas tracers

Cara Manning (MIT-WHOI)



Poster: Net and gross productivity during a Lagrangian experiment in coastal California from gas tracers

Cara Manning (MIT-WHOI)



Model Based Analysis Of Trophic Responses To Changes In Nutrient Stoichiometry In Oxygen Minimum Zones

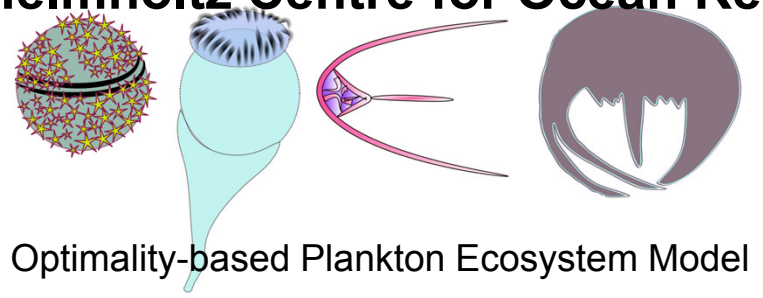
GEOMAR

SFB 754

Optimality-based model analysis of nitrogen and phosphorus cycling in mesocosm experiments of the Peruvian Upwelling region

Alexandra Marki*, Markus Pahlow* and Helena Hauss*

*** GEOMAR Helmholtz Centre for Ocean Research Kiel**



Optimality-based Plankton Ecosystem Model

2015 OCB SUMMER SCIENCE WORKSHOP
WHOI, 22 JULY 2015

DFG

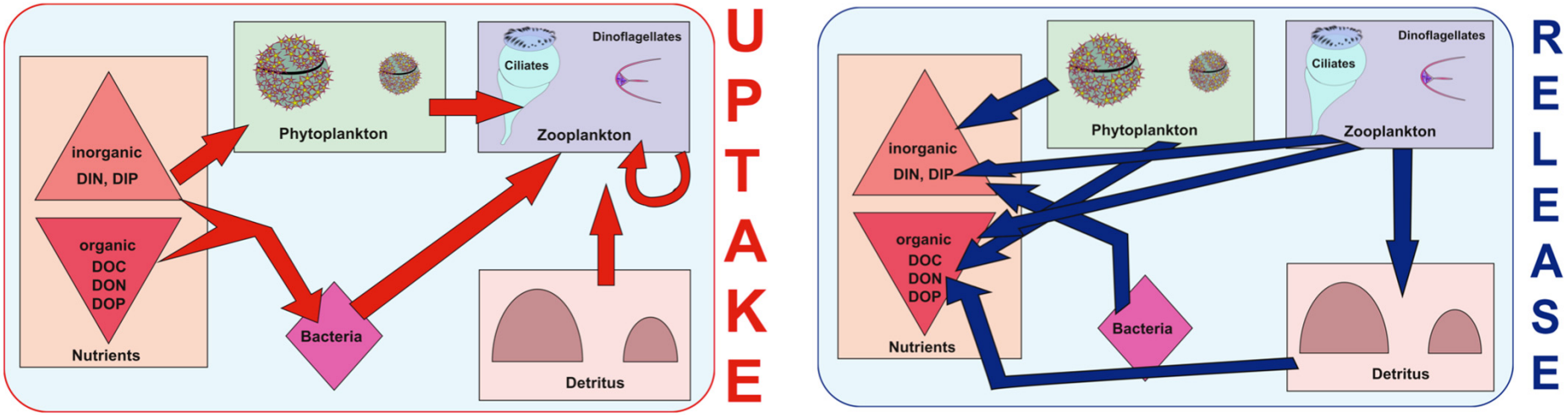
HELMHOLTZ GEMEINSCHAFT

Optimality-based model analysis of nitrogen and phosphorus cycling in mesocosm experiments of the Peruvian Upwelling region

GEOMAR

SFB 754

What drives ecosystem dynamics in mesocosms?



DFG

2015 OCB SUMMER SCIENCE WORKSHOP
WHOI, 22 JULY 2015

HELMHOLTZ GEMEINSCHAFT

Optimality-based model analysis of nitrogen and phosphorus cycling in mesocosm experiments of the Peruvian Upwelling region

GEOMAR

SFB 754

Does plankton stoichiometric plasticity matter?

Does zooplankton feeding behaviour matter?

Do bacteria preferentially take up dissolved inorganic or organic phosphorus?

2015 OCB SUMMER SCIENCE WORKSHOP
WHOI, 22 JULY 2015

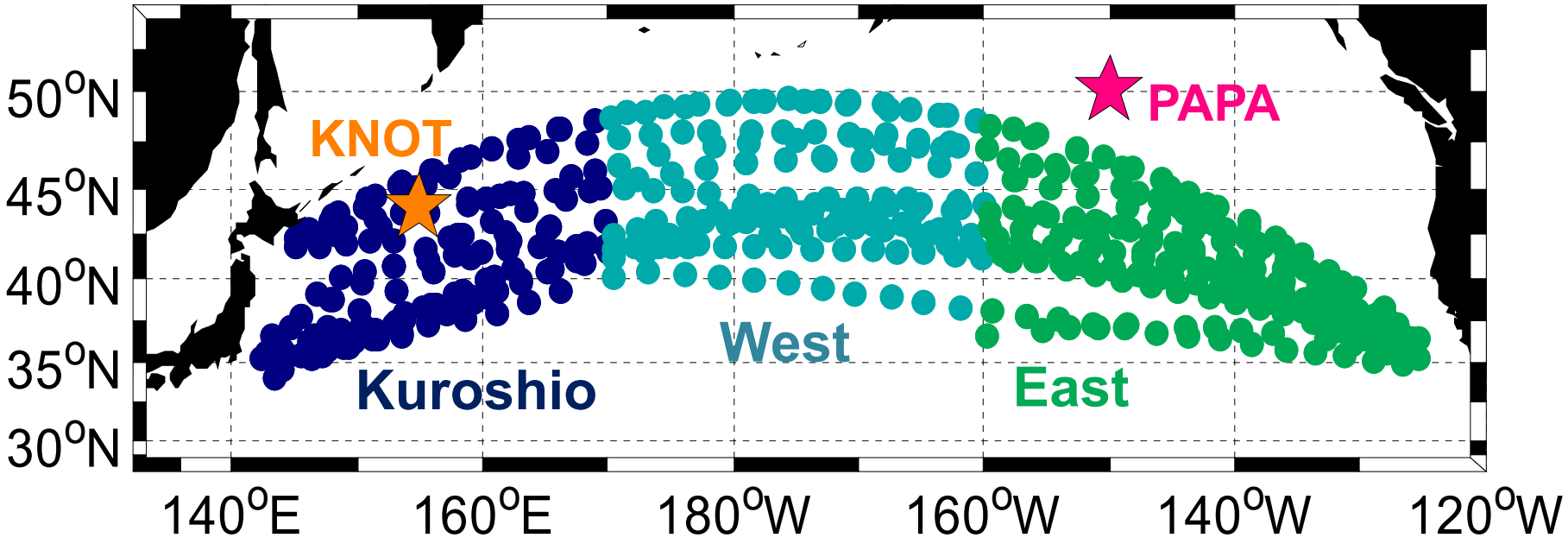
DFG

HELMHOLTZ GEMEINSCHAFT

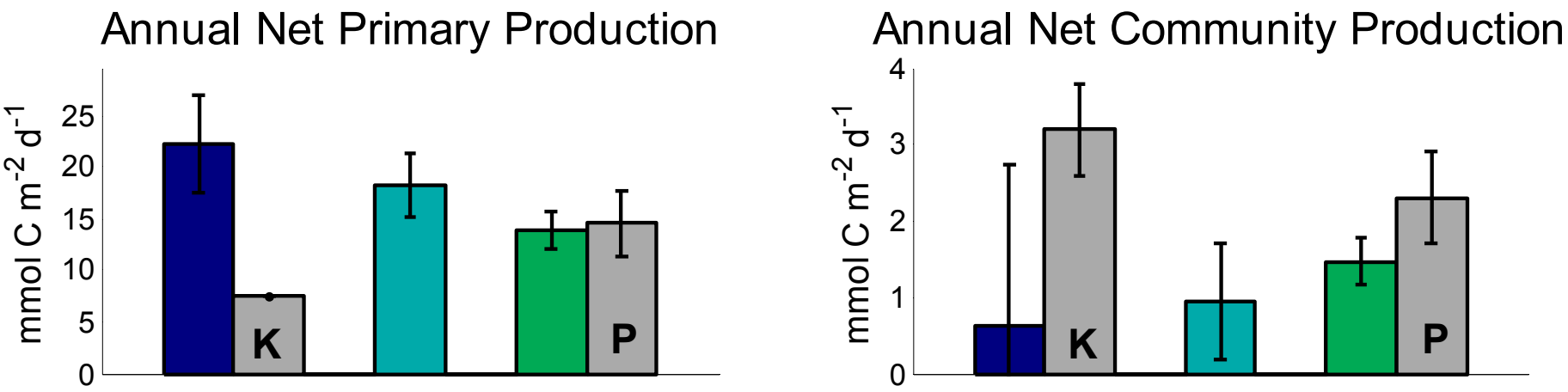
The annual cycle of primary production, net community production and export efficiency across the North Pacific Ocean

Hilary I. Palevsky
School of Oceanography, University of Washington

Co-authors: Paul D. Quay, Deirdre E. Lockwood, David P. Nicholson

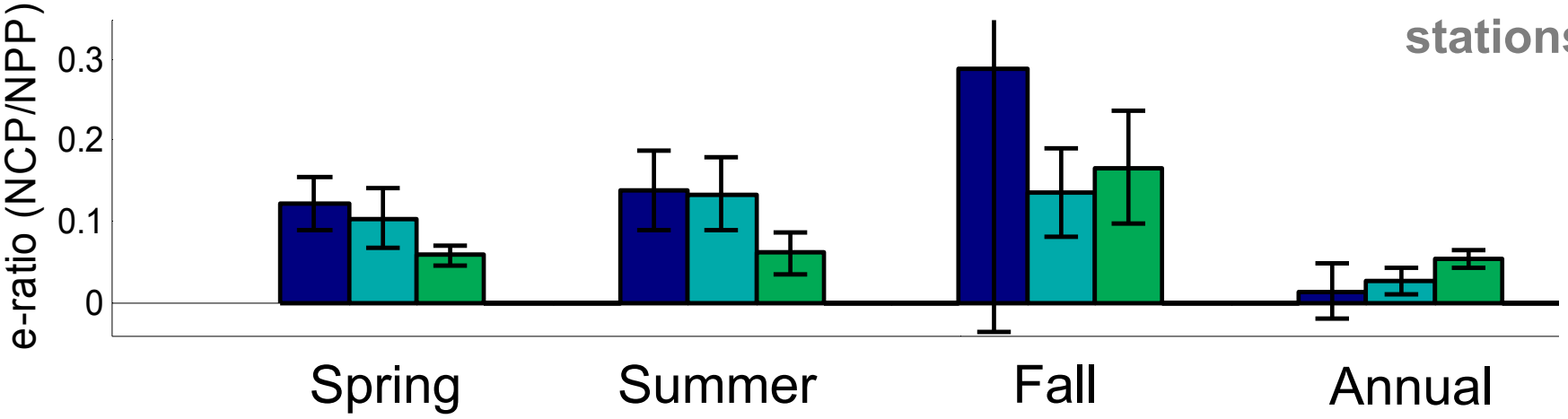


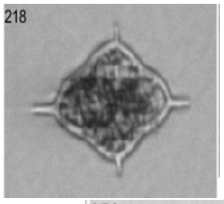
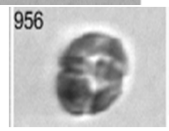
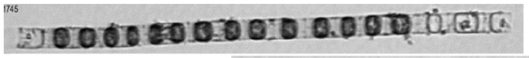
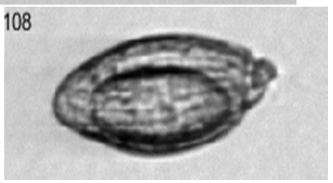
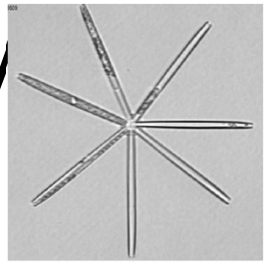
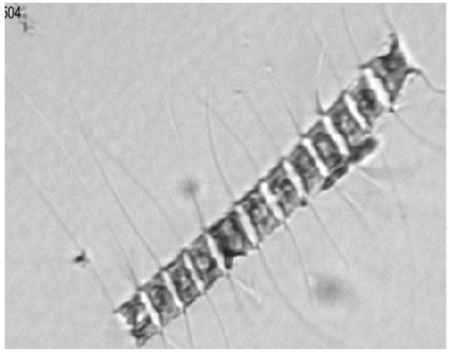
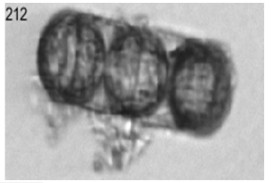
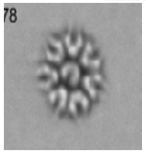
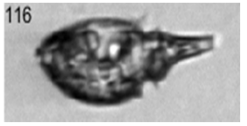
Annual Productivity Rates



Kuroshio
West
East
Time-series stations

Export Efficiency



Fine Scale Phytoplankton Diversity of Galveston Bay

Hannah Preischel

PhD. Student

Department of Oceanography

TEXAS A&M UNIVERSITY

GALVESTON CAMPUS

Phytoplankton Dynamics Laboratory

Texas A&M University at Galveston

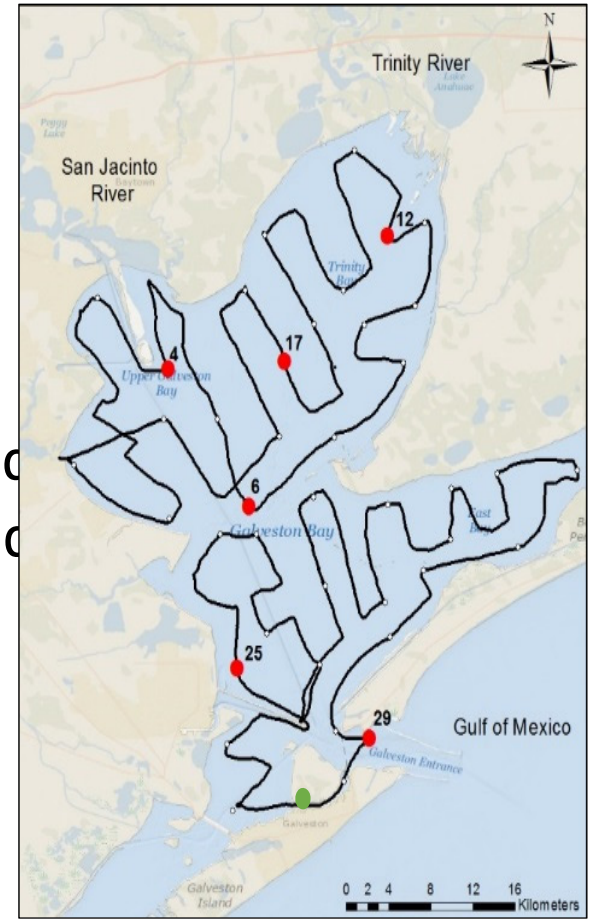
TEXAS PARKS & WILDLIFE

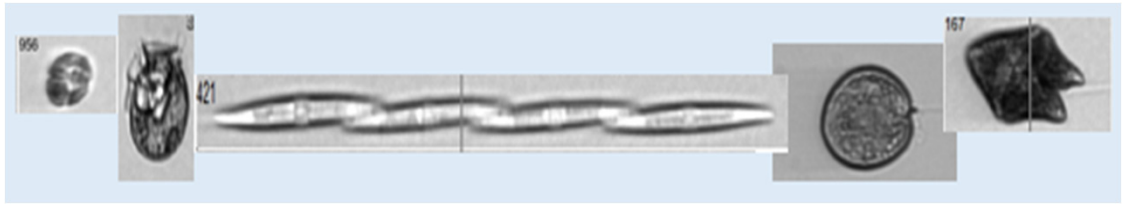
NOAA

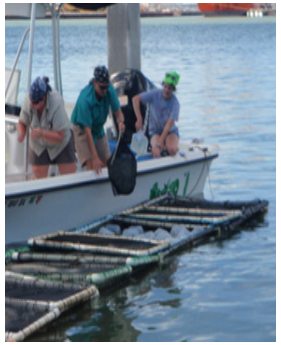
TEXAS COASTAL MANAGEMENT PROGRAM

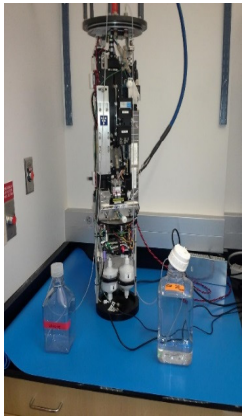
Assessing Diversity

- **Temporal Diversity**
  - Compare to changes in temperature, and
  - Harmful algal bloom (HAB) detection and
  - Create library of phytoplankton types
- **Spatial Diversity**
  - Rivers: flows and salinity gradient
- **Nutrient Bioassay**
  - Competition and community composition shifts with limiting nutrients







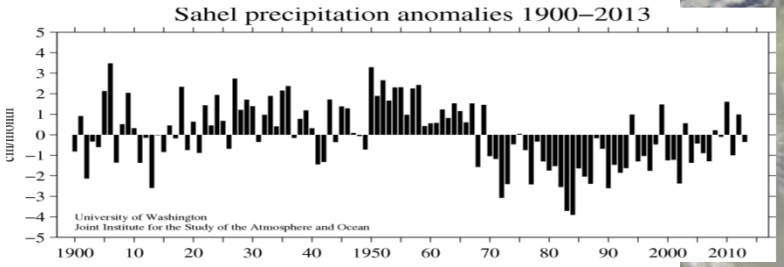


African dust and *Trichodesmium* increase in temperate North Atlantic from 1980-1990's

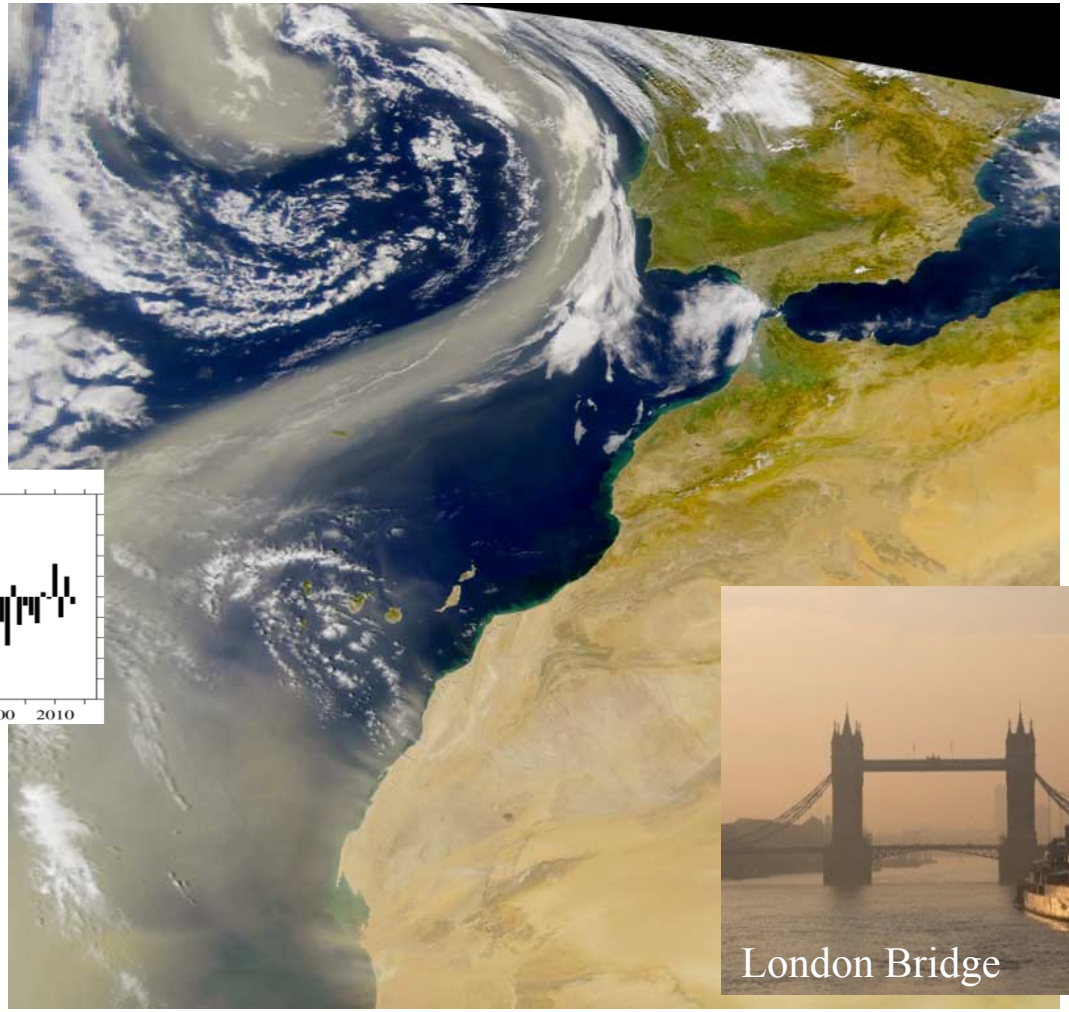
Rivero-Calle S.[1], Del Castillo C.E.[2], Gnanadesikan A.[1], Dezfuli A.[1], Zaitchik B.[1]

sara.rivero@jhu.edu, carlos.e.delcastillo@nasa.gov

Source



Pathway



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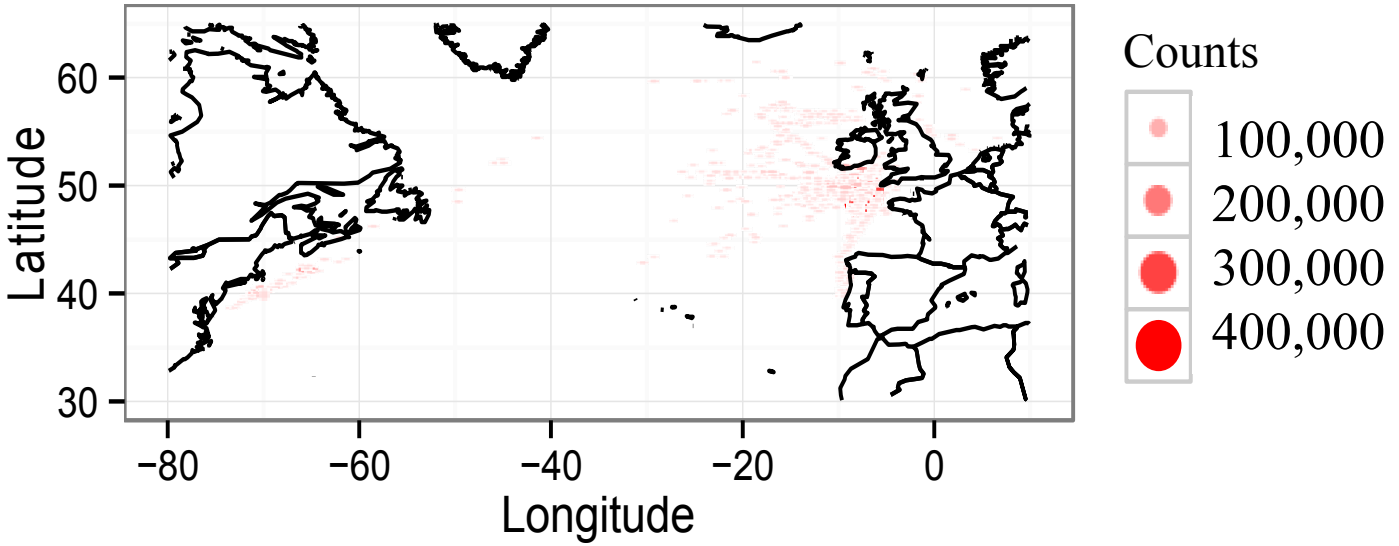
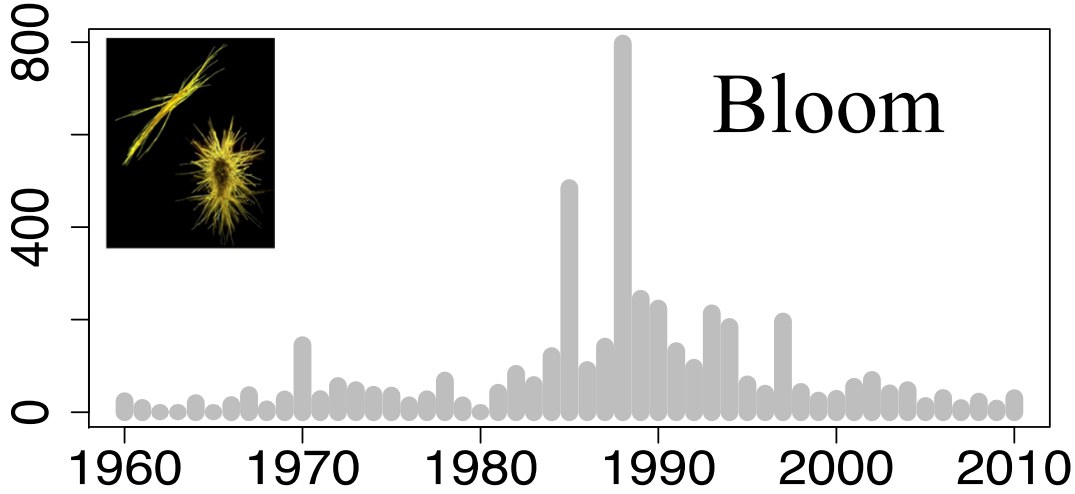
Sir Hardy with CPR



Mean annual *Trichodesmium* counts



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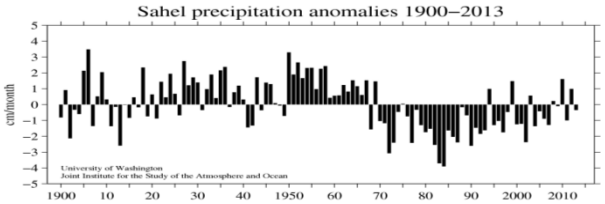
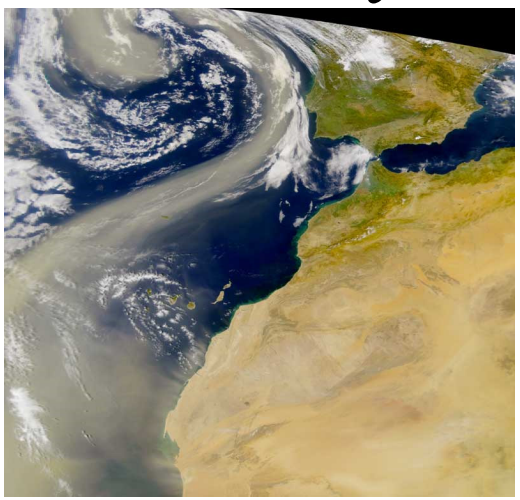


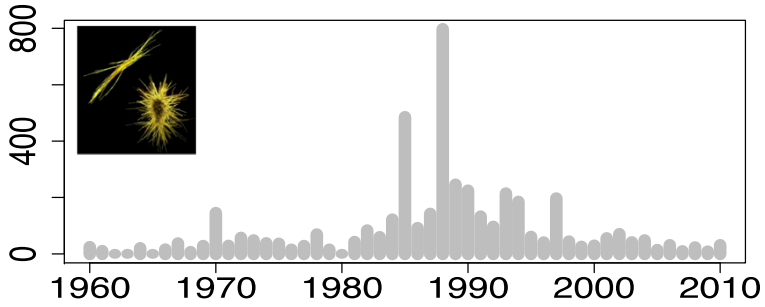
Sir Hardy with CPR

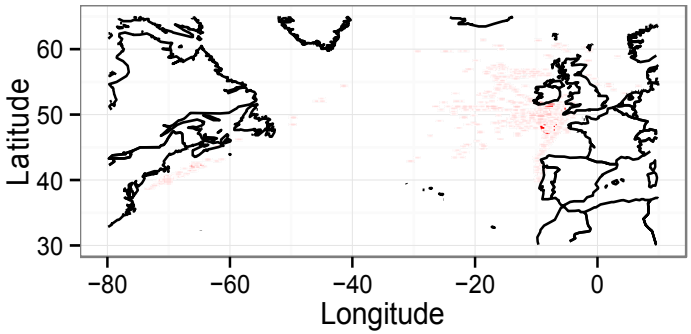
Pathway

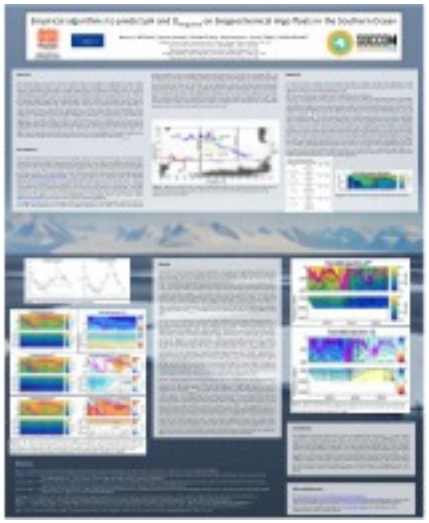


Bloom

mean annual *Trichodesmium* counts





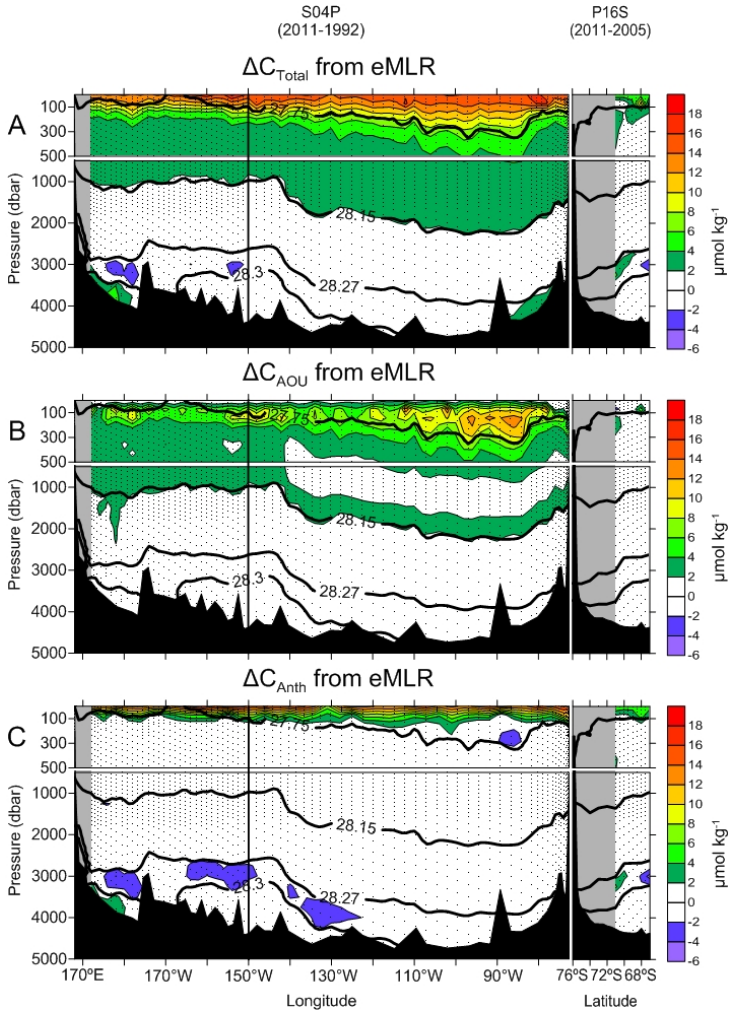


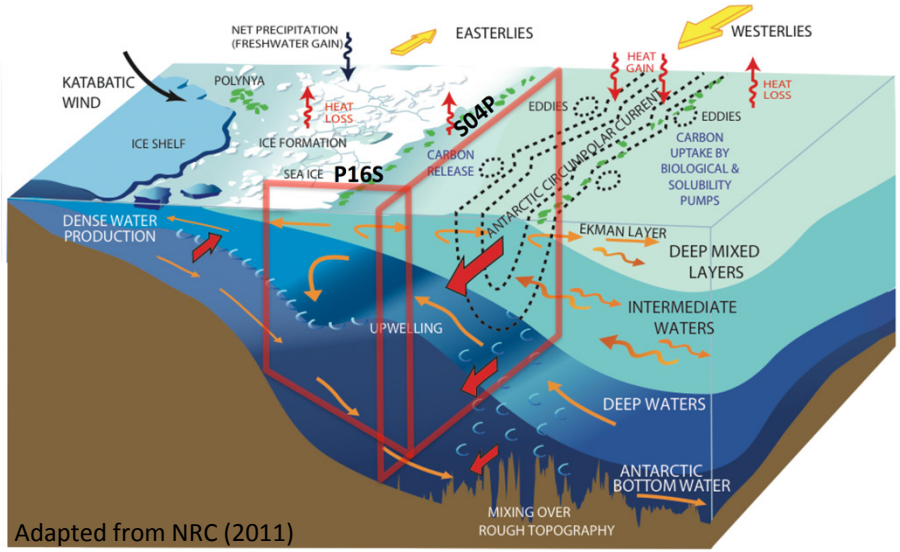
Nancy L. Williams

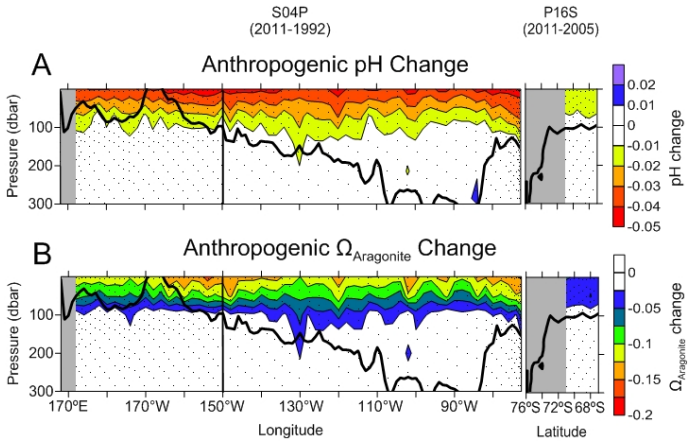
PhD Student at Oregon State University
Advisor: Laurie Juranek
E-mail: nancy.williams@oregonstate.edu

M.S. in Oceanography, University of Washington, 2014
Advisors: Richard Feely and Christopher Sabine of NOAA PMEL

Southern Ocean Anthropogenic Carbon







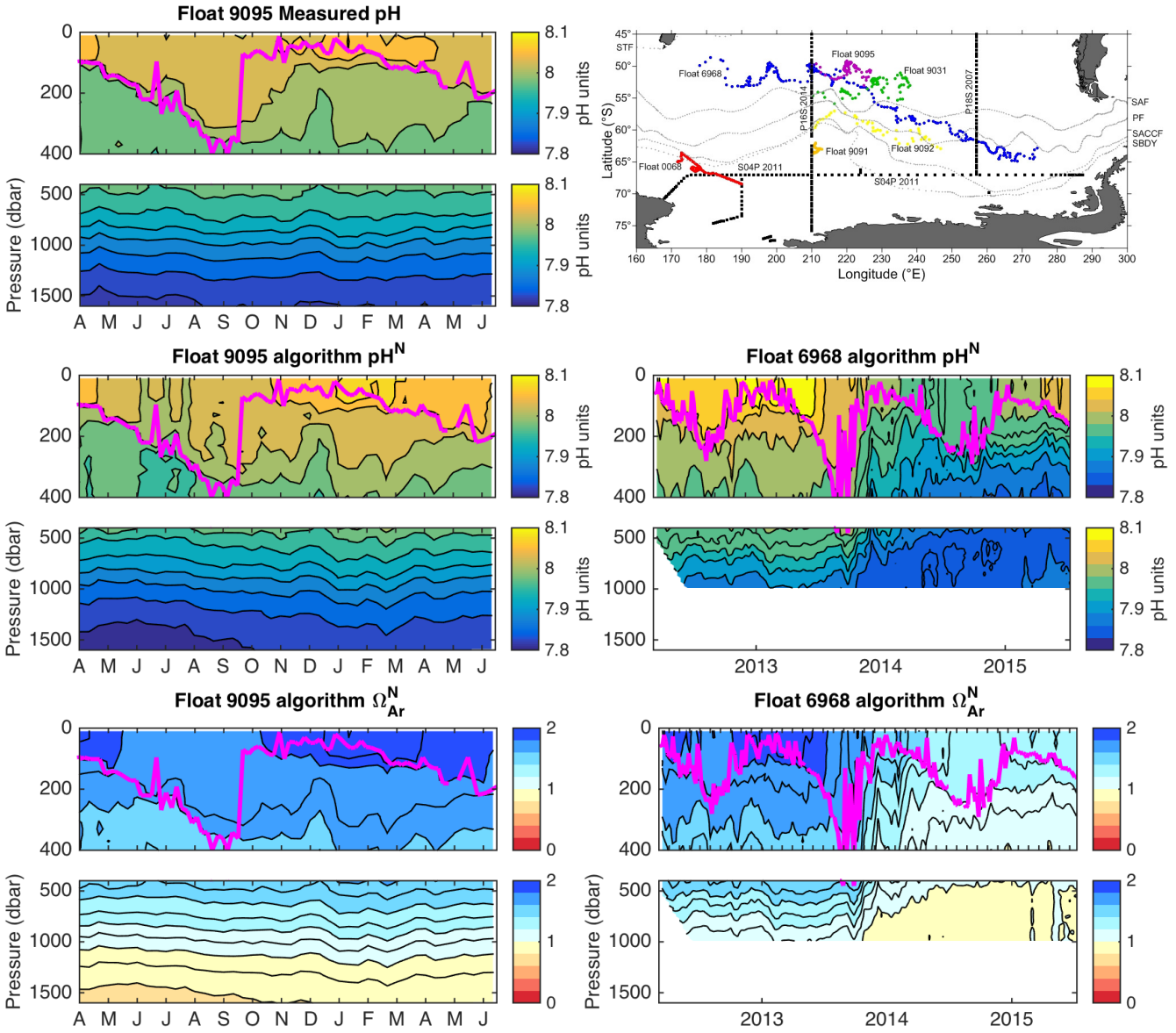
Reference: Williams, N. L., R. A. Feely, C. L. Sabine, A. G. Dickson, J. H. Swift, L. D. Talley, and J. L. Russell (2015), Quantifying Anthropogenic Carbon Inventory Changes in the Pacific Sector of the Southern Ocean, Mar. Chem., 174, 147–160, doi:10.1016/j.marchem.2015.06.015.

SOCCOM

Unlocking the mysteries of the Southern Ocean

Carbon Algorithm Development

Target Variable	Predictor Variables	R^2	rmse
pH^N	Salinity Temperature Pressure Nitrate	0.981	0.010
pH^{Ox}	Salinity Temperature Pressure Oxygen	0.964	0.008
$\Omega_{Ar}{}^N$	Salinity Temperature Sigma Theta Pressure Nitrate	0.983	0.035
$\Omega_{Ar}{}^{Ox}$	Oxygen Salinity Temperature Sigma Theta Pressure	0.982	0.023

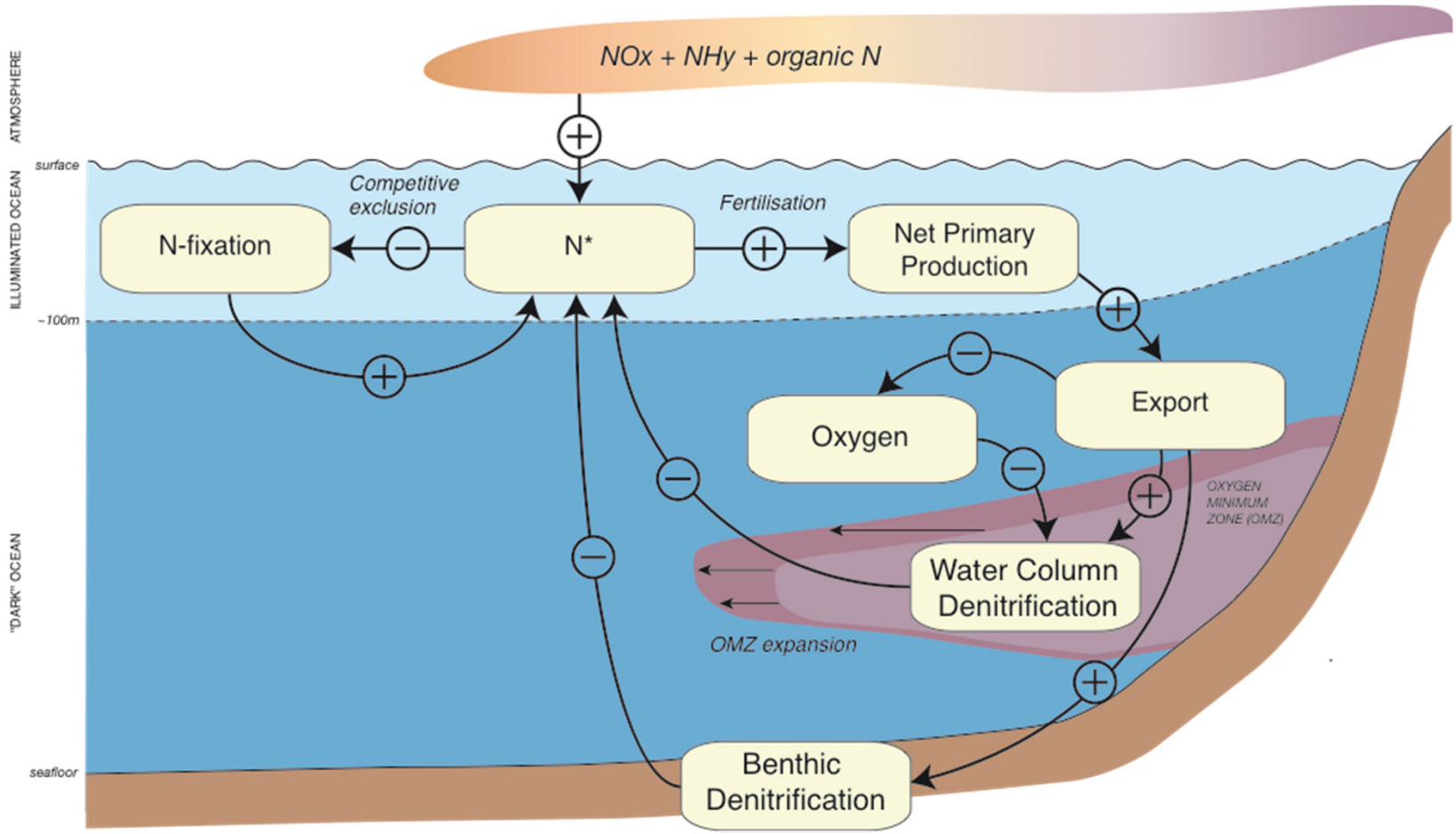


ETH zürich

The marine nitrogen cycle during the Anthropocene

Simon Yang
Supervisor : Nicolas Gruber

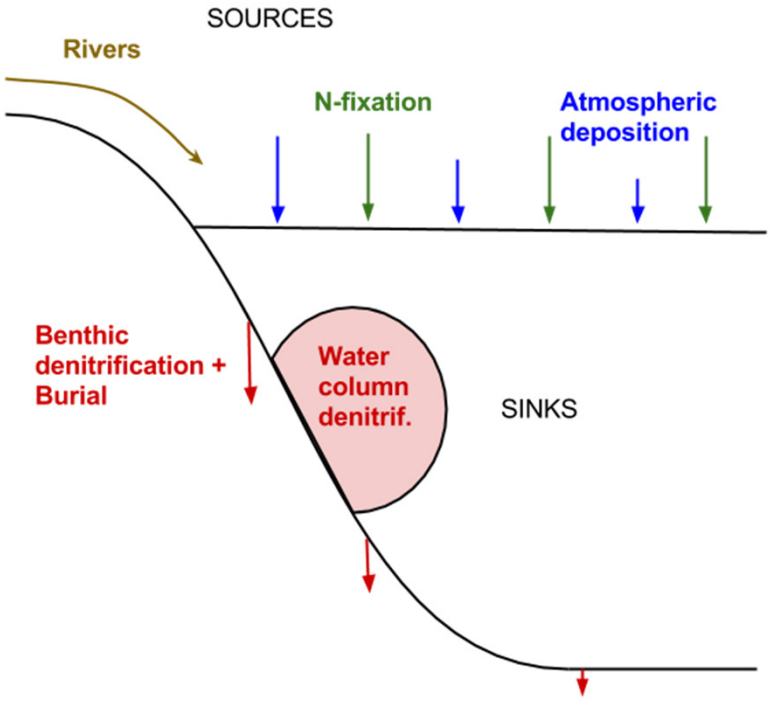
Stabilizing feedbacks in the nitrogen cycle



Yang and Gruber, submitted

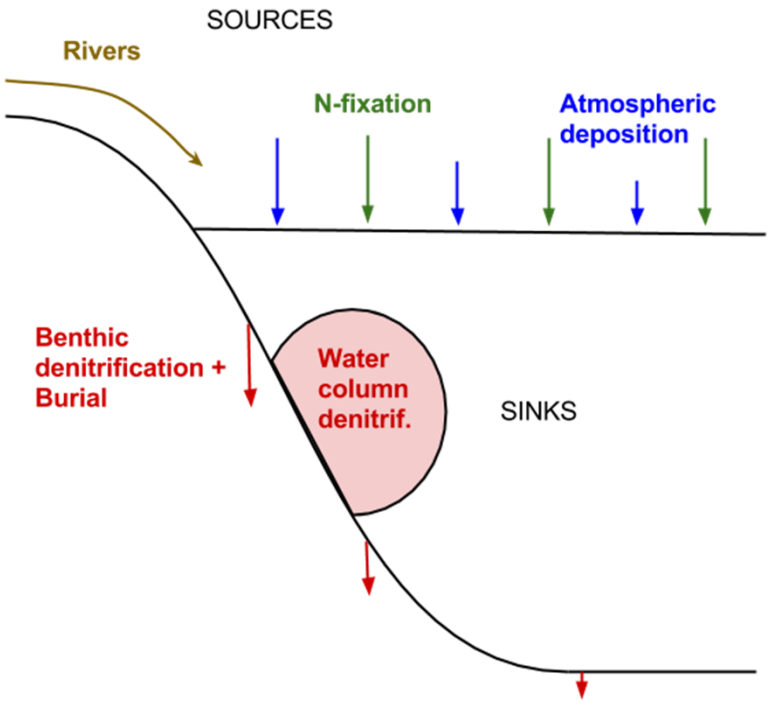
Tool : forced ocean-ice model + comprehensive BGC

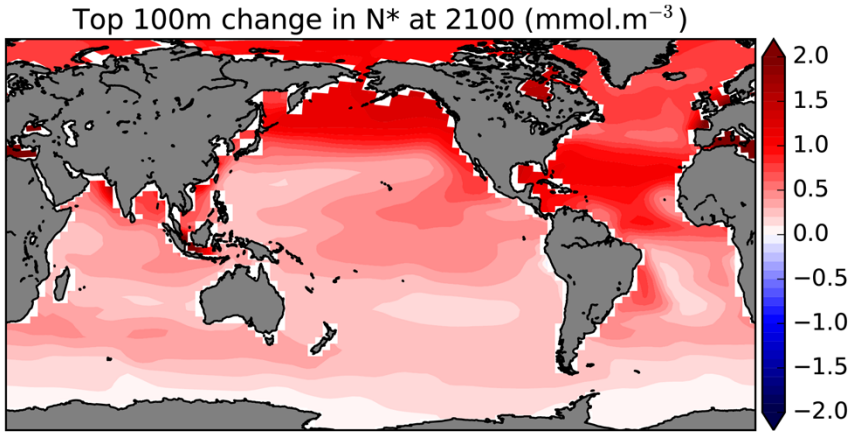
CESM-BEC Nitrogen cycle

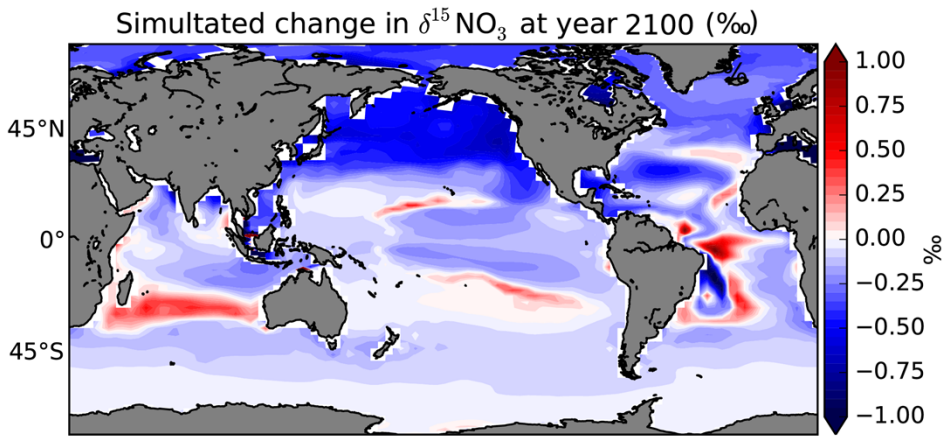


Tool : forced ocean-ice model + comprehensive BGC

CESM-BEC Nitrogen cycle







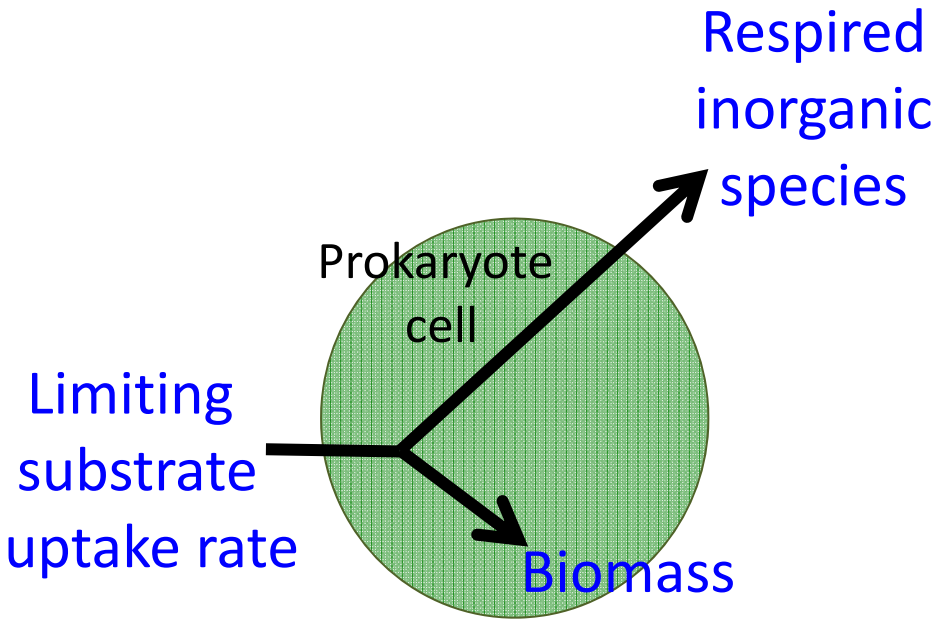
Yang and Gruber, submitted

Linking microbes to climate:
Modeling prokaryotic metabolisms explicitly

Emily Zakem, MIT
Advisor: Mick Follows

Approach: Metabolisms defined by redox reactions.

- **Growth efficiency** from thermodynamics.
- **Growth rate** from uptake limitations.



Hypothesis: Bacterial biogeography and nutrient distributions will emerge from competition of metabolisms.

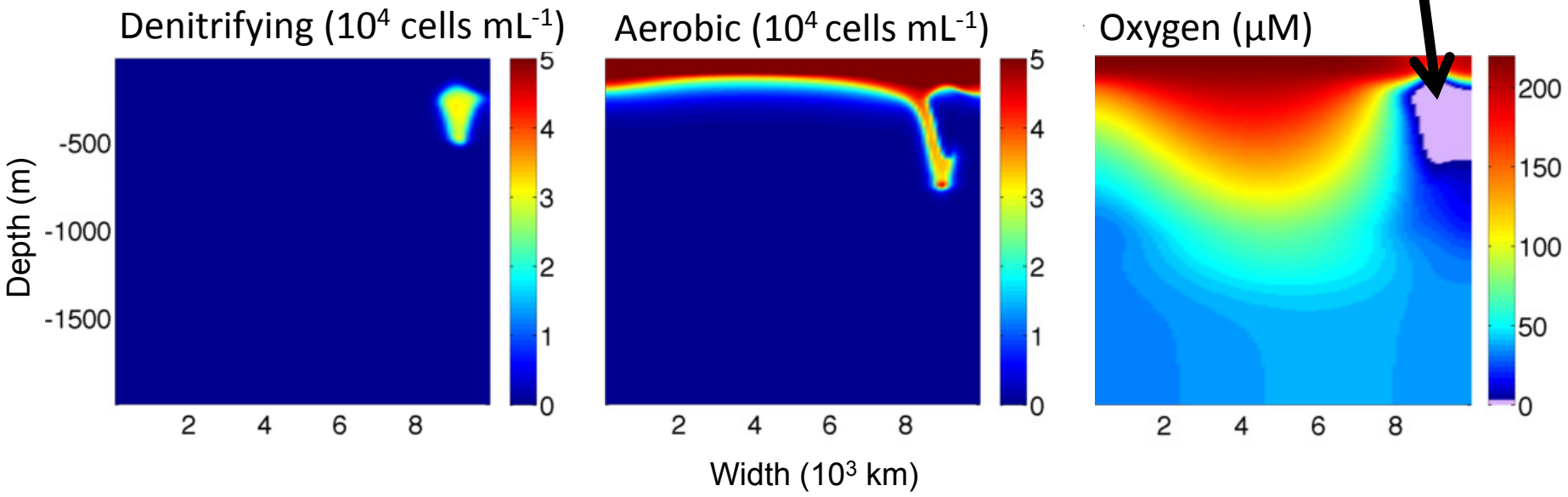
Linking microbes to climate:
Modeling prokaryotic metabolisms explicitly

An idealized oxygen minimum zone
with two heterotrophic functional types:

Aerobic: $OM + O_2 \rightarrow B_O + NH_4^+$

Denitrifying: $OM + NO_3^- \rightarrow B_N + NH_4^+ + N_2$

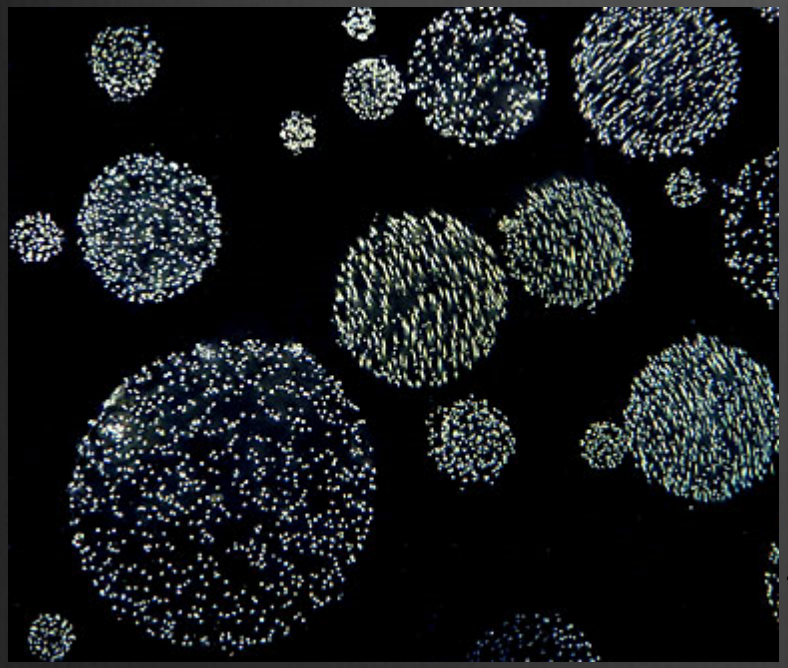
Nanomolar minimum emerges



Emily Zakem


Zhi Zhu
Ph. D Candidate
University of Southern California
USC University of Southern California

Phaeocystis VS Diatom



http://www.phaeocystis.org/

VS

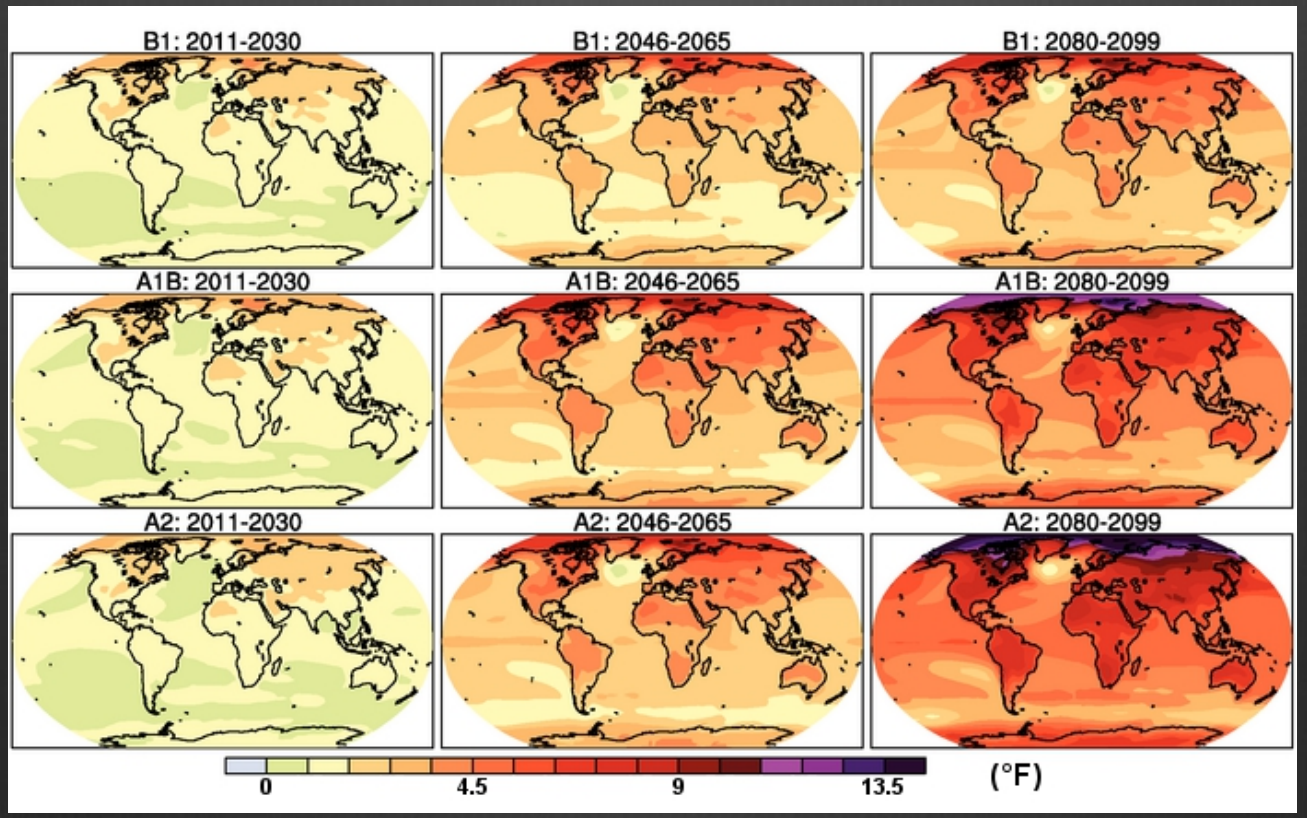
Factors affect phytoplankton community structure

- Phytoplankton community structure in the Ross Sea is related to mixed layer depth (Arrigo et al., 1999)

- Water column temperature may play a significant role in phytoplankton community composition (Liu and Smith, 2012)

Arrigo, Kevin R., et al. Science 283.5400 (1999): 365-367
Liu, Xiao, and Walker O. Smith. Journal of Marine Systems 94 (2012): 135-144.

Global warming and iron input change



IPCC 2007

Evolving Views on Physical, Ecological, and Biogeochemical Underpinnings of Plankton Blooms

Interactive effects of iron and temperature on Antarctic diatoms and *Phaeocystis antarctic*

Zhi Zhu[1], Kai Xu[1], Feixue Fu[1], Jenna Spackeen[2], Deborah A. Bronk[2], David A. Hutchins[1]

1. Department of Biological Science, University of Southern California, Los Angeles, CA
2. Department of Physical Sciences, Virginia Institute of Marine Science, Gloucester Point, VA